RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

#10⁵

Volume XIV

January to June, 1930

Owned and Published by
THE RADIOLOGICAL SOCIETY OF NORTH AMERICA
as its Official Journal

610.5
QR118
v.14

270869
B.P.

DARTMOUTH
COLLEGE
LIBRARY

CONTENTS OF VOLUME XIV

JANUARY

THE QUESTION OF THE FUNDAMENTAL BIOLOGICAL REACTION OF RADIATION. *Prof. Dr. Friedrich Dessauer, Frankfort, Germany* 1

DISCUSSION: *Dr. Arthur W. Erskine, Dr. Francis Carter Wood, Dr. Samuel Brown, Dr. M. J. Sittenfield, and Dr. E. Lorenz* 14

LIMIT EXPOSURE IN RADIOGRAPHY: A SUPPLEMENTARY REPORT. *Ernst A. Pohle, M.D., Ph.D., F.A.C.R., and Cecil S. Wright, B.S., M.D., Madison, Wisconsin* 17

EDUCATION AND INSTRUCTION IN ROENTGENOLOGY. *William H. Meyer, M.D., New York City* 24

FUNDAMENTALS OF ROENTGEN-RAY TREATMENT. *H. J. Ullmann, M.D., Santa Barbara, California* 28

THE DIFFERENTIAL DIAGNOSIS OF SYPHILITIC DISEASE OF THE VISCERA. *Prof. Dr. Franz Groedel, Bad-Nauheim, Germany* 32

INTERPRETATION OF GASTRIC SYMPTOMS: A CLINICAL AND ROENTGENOLOGICAL STUDY OF THREE THOUSAND CASES. *Maurice F. Dwyer, M.D., and John M. Blackford, M.D., Seattle, Washington* 38

DISCUSSION: *Dr. Hans A. Jarre, and Dr. M. F. Dwyer* 43

RADIUM TREATMENT IN SKIN CANCER AND BORDERLINE MALIGNANCIES. *Alden Williams, M.D., F.A.C.P., Grand Rapids, Michigan* 45

THE USE OF SMALL AMOUNTS OF RADIUM AT A DISTANCE IN THE TREATMENT OF CARCINOMA OF THE MOUTH AND FACE. *R. T. Pettit, M.D., Ottawa, Illinois* 55

DISCUSSION: *Dr. Rollin H. Stevens and Dr. Alden Williams* 58

INTRATHORACIC TUMORS: CASE REPORT. *R. P. Potter, M.D., Marshfield, Wisconsin* 60

THE SEEMANN SPECTROGRAPH TELLS THE STORY. *J. W. Du Mond and Archer Hoyt, Pasadena, California* 62

THE VALUE OF THE BI-PLANE FLUOROSCOPIC SCREEN IN THE REDUCTION OF FRACTURES AND THE REMOVAL OF FOREIGN BODIES, ENERGIZING BOTH TUBES AT THE SAME TIME. *L. G. McCutchen, M.D., St. Louis* 66

CASE REPORTS AND NEW DEVICES

CONGENITAL ABSENCE OF RADIUS, WITH OTHER ABNORMALITIES. *A. E. Blackett, M.D., C.M., New Glasgow, Nova Scotia, Canada* 70

SUBASTRAGALOID DISLOCATION OF THE FOOT: REPORT OF CASE. *Joseph F. Elward, M.D., and Laurence S. Otell, M.D., Washington, D. C.* 71

A COOLING SYSTEM FOR USE IN HOT CLIMATES. *C. J. Marshall, M.D., Sanford, Florida* 72

EDITORIAL

CANCER OF THE CERVIX UTERI. *Franklin H. Martin, M.D., F.A.C.S., Chicago* 75

THE ANNUAL MEETING OF THE SOCIETY 78

PORTRAIT OF ROBERT J. MAY, M.D., CLEVELAND, PRESIDENT OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA 79

BESTOWAL OF AWARDS BY THE SOCIETY 81

THE NINTH NATIONAL CONGRESS OF MEDICAL RADIOLOGY 81

FEBRUARY

INFRACLAVICULAR FOCI OF INFILTRATION AS EVIDENCE OF INCIPIENT TUBERCULOSIS OF THE LUNGS IN YOUNG ADULTS. *Prof. Dr. H. Assmann, Leipzig, Germany. Translation by I. Seth Hirsch, M.D., New York* 93

THERMAL EFFECTS OF DIATHERMY. *Allan Hemingway, Ph.D., Minneapolis* 99

GRENZ-RAY THERAPY. *Gustav Bucky, M.D., New York* 126

Discussion: *Dr. Rollin H. Stevens, Dr. Otto Glasser, Dr. H. J. Ullmann, Dr. M. J. Sittenfield, Dr. W. Stenstrom, and Dr. G. Bucky* 132
Radium in the Treatment of Diseases with Subcutaneous or Mucous Membrane Hemorrhages: Preliminary Report. *J. M. Hoffman, M.D., Pensacola, Florida* 136
The Roentgen Treatment of Morbus Basedowii. *Prof. Dr. G. Holzknecht, Vienna* 139
X-ray Diagnosis and Therapy of Thyroid Disease. *John Remer, M.D., and Webster W. Belden, M.D., New York* 145
Discussion: *Dr. P. A. White and Dr. Webster W. Belden* 150
Case Reports and New Devices
Diagnostic Pneumoperitoneum in Diaphragmatic Pathology. *N. S. Zeitlin, M.D., Chicago* 152
A Case of Pharyngeal Diverticulum of Traumatic Origin. *D. Dudley Krupp, M.D., Flint, Michigan* 155
An Accessory Protective Measure in Film Storage. *R. H. Lowry, Major M. C., Fort Sam Houston, Texas* 157
Editorial
Wholesome Co-operation. *Albert Soiland, M.D., Los Angeles* 159
Report of the Publicity and Educational Committee of the Radiological Society of North America for the Year 1929. *B. C. Cushway, M.D., Chicago* 160
Fifth International Congress of Physiotherapy, Liege, Belgium .. 162
Photograph Taken at the Banquet of the Radiological Society of North America, Toronto 163
Would Stimulate Radium Production in United States 165

MARCH

SPECIAL ISSUE—CANCER SYMPOSIUM

Foreword. *Albert Soiland, M.D., Los Angeles, Chairman, Cancer Symposium* 185
Factors Determining Radioresistance in Tumors. *James Ewing, M.D., New York City* 186
Treatment of Malignant Growths of the Nasal Accessory Sinuses and Nasopharynx. *Douglas Quick, M.B. (Tor.), New York City* 191
Radiation Technic for Cancer of the Mouth with Combinations of Gamma Radium Rays and Varying Qualities of High Voltage Roentgen Rays. *B. P. Widmann, M.D., Philadelphia* 197
Advantages and Limitations of External Radiation in the Treatment of Rectal Cancer. *George E. Binkley, M.B. (Tor.), New York City* 207
Results Obtained in the Treatment of Carcinoma of the Cervix Uteri with Radium and Roentgen Rays from 1915 to 1924, Inclusive. *Harry H. Bowing, M.D., and Robert E. Fricke, M.D., Rochester, Minnesota* 211
Carcinoma of the Cervix. *William P. Healy, M.D., F.A.C.S., New York City* 217
Histological Structure, Clinical Grouping, and Prognosis of Cancer of the Uterine Cervix and the Breast. *Henry Schmitz, M.D., and William Hueper, M.D., Chicago* 223
Radium and X-ray Therapy as Palliative Measures in the Treatment of Rectal Cancer. *Isidore Arons, M.D., D.M.R.E. (Cantab.), New York City* 232
Some Economic Aspects of the Cancer Problem. *Albert Soiland, M.D., Los Angeles* 240

Discussion: *Dr. George E. Pfahler, Dr. Douglas Quick, Dr. Henry Schmitz, Edith H. Quimby, M.A., Dr. Francis Carter Wood, Dr. Harold Swanberg, Dr. W. H. McGuffin, Dr. B. P. Widmann, Dr. George E. Binkley, Dr. Robert E. Fricke, Dr. William P. Healy, Dr. Albert Soiland* 243

Radiosensitive Tumors and Tumors that First should be Subjected to Operation. *Joseph Colt Bloodgood, M.D., Baltimore* 254

The Contributions of Experimental Studies to Radiotherapy. *Francis Carter Wood, M.D., New York City* 263

Roentgen Diagnosis and Treatment of Thymomata. *Howard P. Doub, M.D., Detroit* 267

Discussion: *Dr. P. M. Hickey, Dr. George E. Pfahler, Dr. Lester A. Smith, Dr. H. P. Doub* 279

Roentgen Diagnosis of Cancer of the Esophagus. *John T. Farrell, Jr., M.D., Philadelphia* 282

Discussion: *Dr. Sydney J. Hawley, Dr. Maurice Feldman, Dr. A. L. Lockwood, Dr. Chevalier Jackson, Dr. J. T. Farrell, Jr.* 292

Osteogenic Tumor: Growth Injury of Bone and Muscular Atrophy Following Therapeutic Irradiation. *Arthur U. Desjardins, M.D., Rochester, Minnesota* 296

Discussion: *Dr. Francis Carter Wood, Dr. A. U. Desjardins* 307

Treatment of Malignant Tumors of the Eye and Orbit by Radiation. *Frederick Hase Rodenbaugh, M.D., San Francisco* 309

APRIL

Fewer Variable Factors in Roentgen Therapy. *Arthur W. Erskine, M.D., Cedar Rapids, Iowa* 317

The Analgesic Effects of Roentgen Rays, with Especial Consideration of Bone Metastases of Cancer. *J. Borak, M.D., Vienna, Austria* 328

Introduction to the Symposium on Dosimetry. *Ernst A. Pohle, M.D., Ph.D., Madison, Wisconsin* 339

The Development of Dosimetry: An Historical Sketch. *Egon Lorenz, Ph.D., Cambridge, Massachusetts* 340

Erythema and Tolerance Doses in American Clinics: A Statistical Study. *Otto Glasser, Ph.D., and U. V. Portmann, M.D., Cleveland, Ohio* 346

Studies of the Roentgen Erythema of the Human Skin. III.—Macroscopic and Skin Capillary Changes after Combined Exposure to Roentgen Rays and Ultra-violet Rays. *Ernst A. Pohle, M.D., Ph.D., F.A.C.R., and Cecil S. Wright, B.S., M.D., Madison, Wisconsin* 351

Discussion: *Dr. A. U. Desjardins, Dr. W. E. Chamberlain, Lauriston S. Taylor, M. M. Schwarzschild, Gioacchino Failla, Otto Glasser, Dr. E. A. Pohle* 359

A Study of the Halogenated Oils Employed in Roentgenology. *D. L. Tabern, N. A. Hansen, E. H. Volwiler, and L. A. Crandall, Chicago* 364

The Precise Measurement of X-ray Dosage. *Lauriston S. Taylor, Washington, D. C.* 372

Effective *versus* Sphere Gap Voltages. *A. Mutscheller, Ph.D., New York* 385

The Effect of Technic on the Speed of Intensifying Screens. *Frank E. Swindells, Ph.D., Towanda, Pennsylvania* 387

Mesenchymatous Tumors of the Lung and Pleura. *I. Pilot, M.D., Chicago* 391

Discussion: *Dr. E. L. Jenkinson and Dr. I. Pilot* 400

Determination of Radiation Values in Lung Tissue with Variable Qualities of Radiation. *J. L. Weatherwax, M.A., and Charles Robb, E.E., Philadelphia* 401
Discussion: *Dr. John T. Farrell, Jr., G. Failla, and J. L. Weatherwax* 409
Roentgen Therapy in Acute Inflammatory Conditions. *Ernst A. May, M.D., Newark, New Jersey* 411
Editorial
Citation for Bravery 416
X-ray Standardization Program of the Bureau of Standards 416
Ten Thousand Dollar Annual Prize Award for Most Valuable Achievement in Science 417
Walter Teed Bronson: 1887–1929 418
R. C. Baumgarten: 1890–1930 420
Dinner in Dr. Butler's Honor 420
Texas Radiological Society 420
Communication. *S. Gilbert Scott, M.R.C.S., L.R.C.P., D.M.R.E. (Camb.), London* 421
Esophageal Obstruction: A Plea for the Use of the Bread Crumb Method. *A. E. Barclay, M.D., D.M.R.E. (Camb.), Cambridge, England* 422
Fifth International Congress on Physiotherapy 423
Correction 424

MAY

Hodgkin's Disease, with Bone and Skeletal Muscle Involvement. *I. H. Lockwood, M.D., E. T. Johnson, M.D., and Frederick C. Narr, M.D., Kansas City, Missouri* 445
Discussion: *A. U. Desjardins, M.D.* 452
Safeguarding the Storage of Photographic, Motion Picture, and X-ray Films. *C. R. Brown, Washington, D. C.* 454
Factors of Error in the Roentgenologic Diagnosis of Diseases of the Colon. *Harry M. Weber, M.D., Rochester, Minnesota* 460
Discussion: *Paul C. Hodges, M.D., and Harry M. Weber, M.D.* 466
A Chemical Method for the Measurement of Quantity of Radiation. *Edith H. Quimby, M.A., and Helen R. Downes, Ph.D., New York City* 468
The Roentgen Diagnosis of Duodenal Ulcer. *L. H. Garland, M.B. (U. C., Dublin), San Francisco, California* 482
Persistent Congenital Atelectasis. *Cassie B. Rose, M.D., Chicago, Illinois* 488
Discussion: *W. W. Wasson, M.D., and A. H. Rolph, M.D.* 492
A Positive Sign of Extensive Destruction of the Mastoid of Infants. *Amedee Granger, M.D., F.A.C.R., O. de L'I. P. (France), New Orleans, Louisiana* 495
Hypoparathyroidism as a Complication of Thyroid Surgery. *Otis M. Walter, M.D., Chicago, Illinois* 504
Discussion: *A. C. Ivy, M.D., and Otis M. Walter, M.D.* 506
Diverticula of the Esophagus. *Edward L. Jenkinson, M.D., Chicago, Illinois* 508
Discussion: *P. M. Hickey, M.D., C. H. Heacock, M.D., and Lester Levyn, M.D.* 512
Editorial
Prevention of Malpractice Claims 514
Important Announcement Regarding the 1930 Meeting. *I. S. Trostler, M.D., Chicago* 517

Post-graduate Course of the German Society of Radiology 520
Legal Status of Hospital Records (*reprinted*) 520
National Hospital Day 521
Chicago Radiological Technicians' Association 522
Communication. *Leopold Jaches, M.D., New York City* 523
Indiana Roentgen Society 523
Heart Beat Started by Radio-active Potassium 523

JUNE

The Problem of International X-ray Standardization. *Lauriston S. Taylor, Washington, D. C* 551
Discussion: *Dr. G. Failla, Edwin C. Ernst, M.D., J. E. Gendreau, M.D., and Dr. L. S. Taylor* 554
Echinococcic Involvement of Bone, with a Case Report. *Robert S. Stone, M.A., M.D., San Francisco, California* 557
Discussion: *W. E. Chamberlain, M.D., and Paul C. Hodges, M.D.* 560
Echinococcus Involvement of the Bones: Report of a Case, with X-ray Examination. *C. K. Hsieh, M.D., Peiping, China* 562
The Value of a Lateral View in the Diagnosis of Pregnancy. *G. W. Grier, M.D., F.A.C.P., F.A.C.R., Pittsburgh, Pennsylvania* 571
The Status of Ultra-violet Ray Therapy in Diseases of the Skin. *Arthur E. Schiller, M.D., Detroit, Michigan* 576
The Value of the Carbon Arc as a Source of Ultra-violet for General Irradiation. *Clarence L. Hyde, M.D., East Akron, Ohio* 582
Report of Six Cases of Malignant Melanoma Treated with X-radiation, with Two Cases Cured for Over Five Years. *H. B. McEuen, M.D., Jacksonville, Florida* 587
Spontaneous Pneumoperitoneum in Ruptured Peptic Ulcer. *Chester H. Warfield, M.D., Chicago, Illinois* 591
Results of Treatments of Fibroid Uteri with Roentgen Ray: A Series of Fifty Cases. *E. C. Franing, M.D., Galesburg, Illinois* 594
Case Reports and New Devices—
Efficiency Engineering in the Dark Room: A Mechanical Conveyor and Automatic Timer for the Wash Tank, with Removal of the Washing and Drying Operations to the Daylight. *W. Edward Chamberlain, M.D., San Francisco, California* 597
Attachment for Sweet Eye Localizer. *Harold G. F. Edwards, M.D., Shreveport, Louisiana* 600
Hernia through the Esophageal Opening of the Diaphragm. *C. C. Anderson, M.B., Ch.B., D.M.R.E., Dunedin, New Zealand* 602
Editorial—
The Problem of Enlarged Thymus. *Howard P. Doub, M.D., Detroit, Michigan* 605
Minnesota Radiological Society 606
The Coffey-Humber Cancer Treatment 607
Legal Medicine. *I. S. Trostler, M.D., Chicago, Illinois* 607
Book Reviews 82, 424, 525, 608
Abstracts of Current Literature 65, 82, 138, 166, 425, 527, 609
Index to Volume XIV 631

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. XIV JANUARY, 1930 No. 1

THE QUESTION OF THE FUNDAMENTAL BIOLOGICAL REACTION OF RADIATION[1]

By PROF. DR. FRIEDRICH DESSAUER, FRANKFORT, GERMANY

SINCE 1922 the author has published the results of some investigations of his hypothesis explaining the fundamental biological reaction of radiation. Other authors, including Simonds (1) and Crowther (2), have made similar investigations to solve this problem, while still others have opposed the author's hypothesis. The experiments to be reported now were undertaken in an endeavor to decide about the correctness of the hypothesis. It may be necessary, however, again to remind you briefly of the principle of this hypothesis.

The absorbed energy of the radiation producing strong biological effects is very small and amounts to a few calories only. From this fact it can be concluded that the energy cannot act as a uniform increase of temperature throughout the biological medium, but must, instead, produce heat at discrete, very small points. In this case the local amount of energy can be large, however small it is on the whole. The other biological reactions follow this fundamental effect. This idea of the action of rays at discrete points is supported by the experimental fact of physics that the action is caused by the impact of electrons. Part of the absorbed energy of the X-rays, gamma rays, or ultraviolet rays reappears as kinetic energy of photo and scattered electrons, which lose velocity on their path through the matter; this loss of energy occurs at discrete points.

A third idea of the hypothesis is that large molecules, especially protein molecules, are important in the biological subject. If a protein molecule receives one or several such impacts, it will react. This reaction may be either specific or non-specific. We have a specific reaction if there is a close relation between the transferred energy and the physical and chemical structure at the point of action, as in photochemical reactions. In this case, only accumulations of energy of *definite* quantity can react with matter of *definite* structure. On this assumption Holthusen (3) has founded his objections to the hypothesis of the author. This hypothesis of energy concentrated at discrete points (*Punktwärmen*) assumes, in opposition to Holthusen, a general effect as the fundamental reaction for the ordinarily destructive actions of rays. It states: If at the point of action, *e.g.*, a protein molecule, the accumulation of energy is great enough, a fundamental reaction takes place in the protein molecule that may be called denaturation. The further effects are combined with it. This non-specific reaction may be imagined as an effect of motion in analogy with the heat, *i.e.*, as an extension of an impulse of motion of atoms excited by impacts. This impulse of motion ordinarily will take place in the molecule itself

[1]Read by E. Lorenz, Ph.D., for the author before the Radiological Society of North America at the Fourteenth Annual Meeting, at Chicago, Dec. 3–7, 1928.

for a long enough time to produce an effect. Electrons cannot produce a translational motion on atoms or molecules directly, but the elementary effect of heat is motion of particles. The consequences of this hypothesis agree well with the facts. Further-

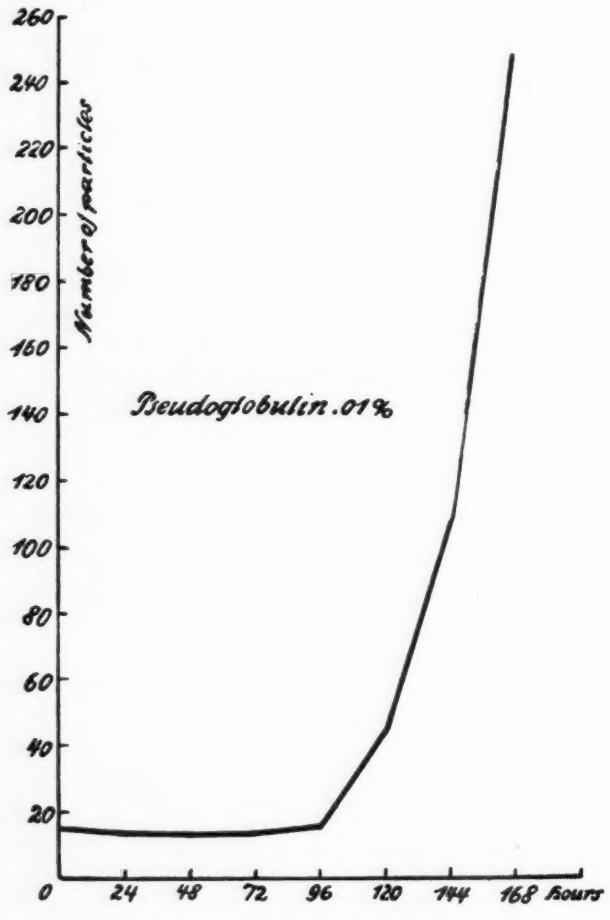

Fig. 1.

indirectly by the excitation of atoms resulting from collisions of the second kind. Rise of temperature will take place at the points bombarded by electrons. A large molecule will be shaken by these impacts, so to speak, and the coupling between its component parts will be diminished. From this conception the second word, "heat," in the term "point-heat" (*Punktwärme*), is derived, because more, it follows that the limit of non-specific reactions of this kind must lie in the ultraviolet region, at least for the protein molecules. This fact has already been reported in the first publication.

The plan of the experiments resulted from these ideas. Following the work of Fernau (4), Fernau and Pauli (5), Wels (6), Wels and Thiele (7), our problem was

to investigate what happened in a solution of protein after irradiating it under exact conditions. According to the hypothesis it was to be expected that the protein molecules of this solution would be denatured, and would then become visible in Brownian movement (in the ultra-microscope) by conglomeration. From the manner of their appearance and disappearance conclusions can be drawn as to the cause. My collaborator, Dr. Nakashima (8), made these experiments, exactly counting and studying the

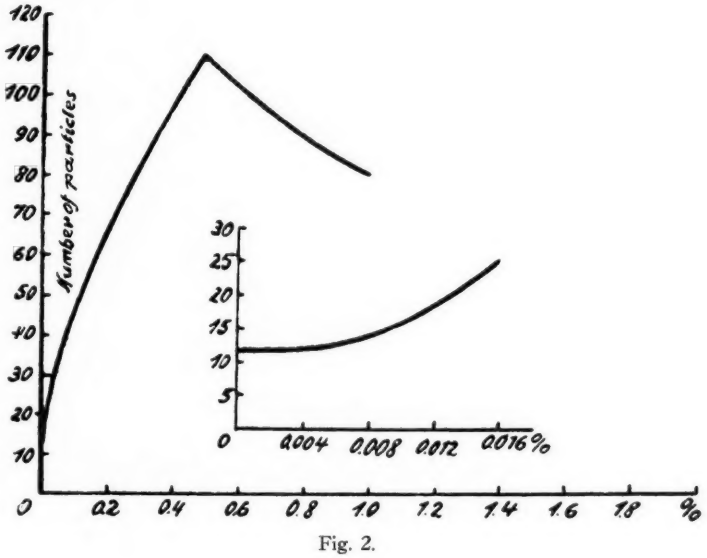

Fig. 2.

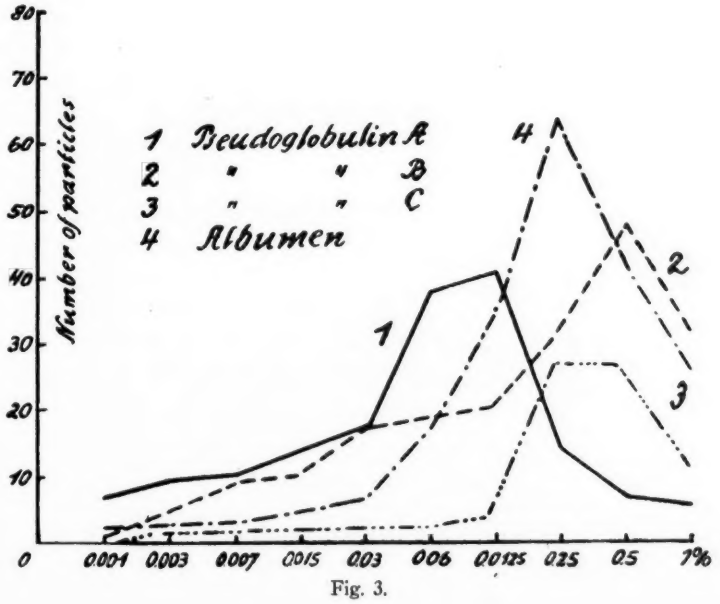

Fig. 3.

appearance, the increase, and the disappearance of the coagulated particles of proteins in Brownian movement with the ultramicroscope. Furthermore, he compared the phenomena with those occurring in the same solutions upon heating them. The results of his investigations showed that the method of exactly counting the particles as they become visible in the solutions is not only of value in learning what happens in the protein, but also is an aid in solving the problem of the fundamental reaction of radiation.

The investigations to be reported now have been carried out very carefully by my collaborators, Dr. Rajewsky and Dr. Schwerin. They confirm Nakashima's re-

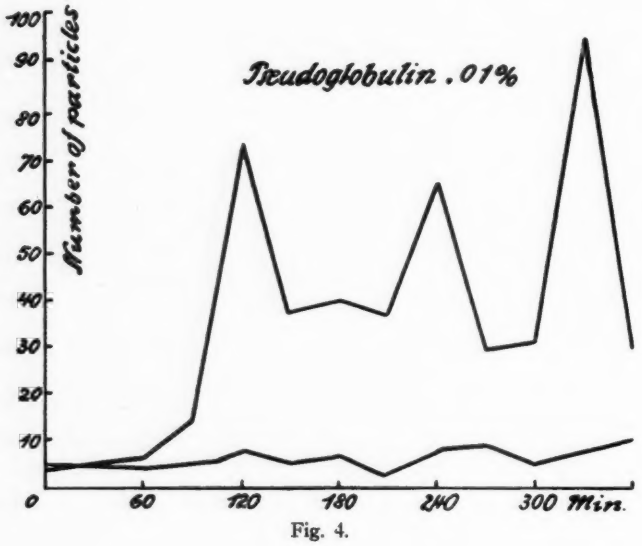

Fig. 4.

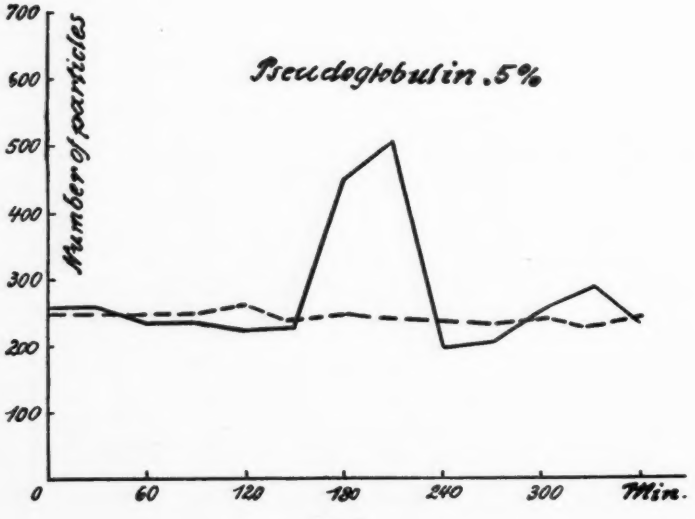

Fig. 5.

sults in all important points, also the detailed correspondence, found by him, between the action of radiation and of heat. In the following figures is given some material about the method and the experiments themselves, in order that some conclusions may be drawn from them.

Generally the experimental arrangement is as follows: a well defined, pure solution of protein (pseudoglobulin), on an average of 0.01 per cent, is irradiated by doses of ultra-violet and X-rays of different wave lengths, measured under exact conditions and careful controls. Contrary to the first experiments of Nakashima, these solutions were not buffered, because it was possible

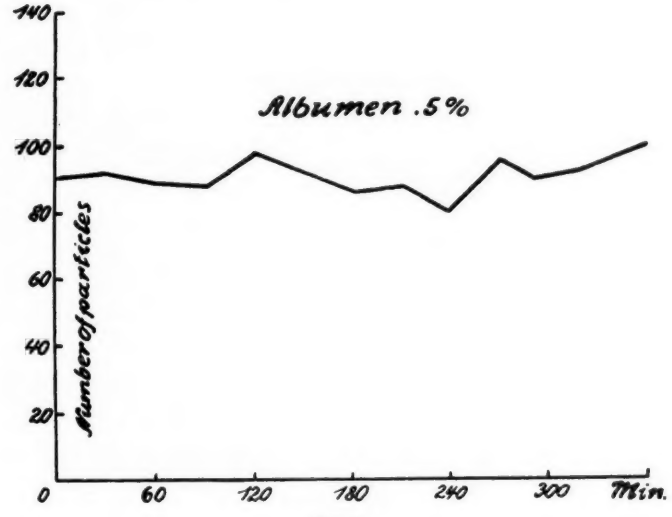

Fig. 6.

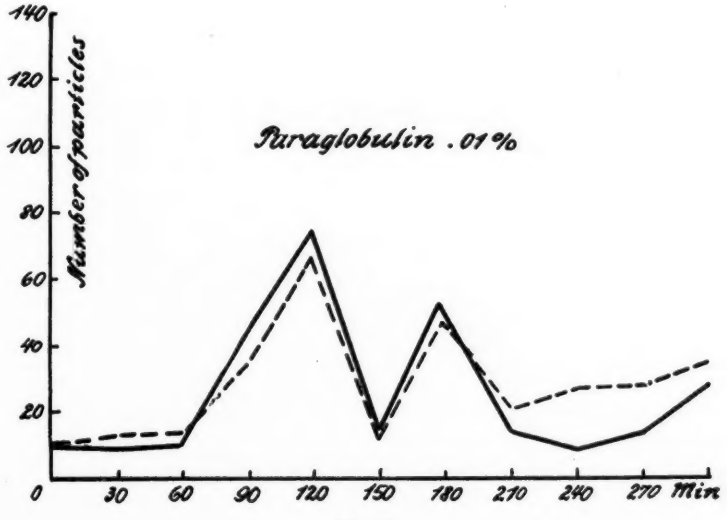

Fig. 7.

thereby to state whether or not the irradiation had any influence on the concentration of hydrogen ions.

Each solution of this kind shows a few particles in Brownian movement, even if not irradiated. The number of the visible particles depends upon accompanying circumstances, especially, if one does not work carefully, on the adaptation of the eye. These accompanying circumstances were removed in the first experiments. After some preparation the observer counts in the same solution under the same conditions the same number of particles in Brownian movement, with a very small factor of error. In order to count them a few drops of the irradiated solution are put into the counting chamber of the microscope. It is first observed that there is a relation between the number of particles in a protein solution and its age (Fig. 1). The number of particles does not change for about a hundred hours, after which it increases rapidly. Within these hundred hours the observations must be

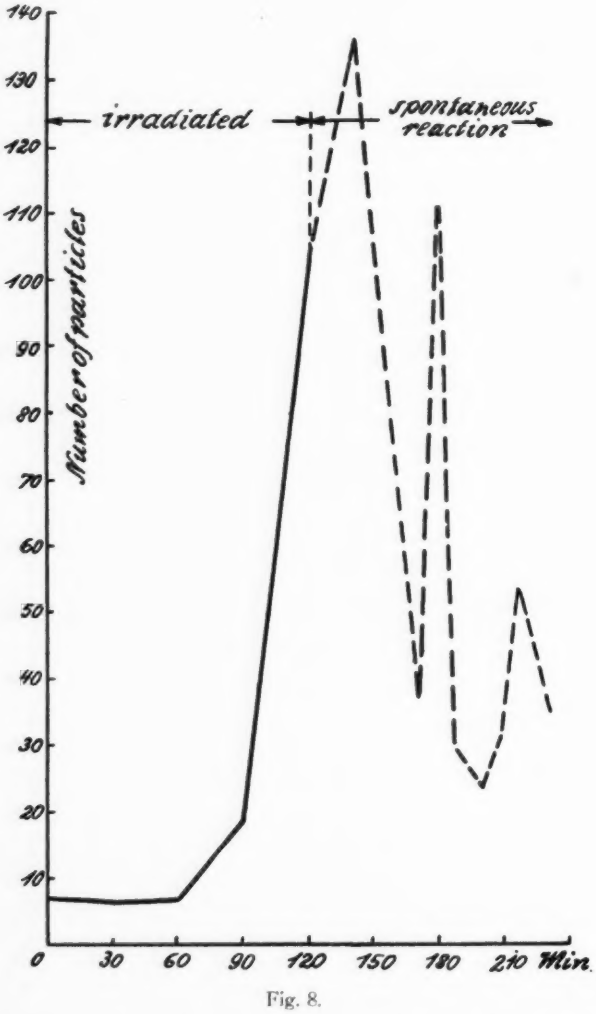

Fig. 8.

made. Furthermore, the number of particles in the solution which is not irradiated depends upon its concentration. Figures 2 and 3 show this dependence for pseudoglobulin and other proteins. The results of these experiments show that very diluted solutions are especially suitable, because they give the best conditions for counting. For all solutions water free from any electrolytes was used. The hydrogen ion concentration of the solution of 0.01 per cent globulin used for the decisive experiments was $P_H = 6, 4$.

Figures 4 and 5 show the reaction of pseudoglobulin of different concentration, when irradiated. The procedure of the ex-

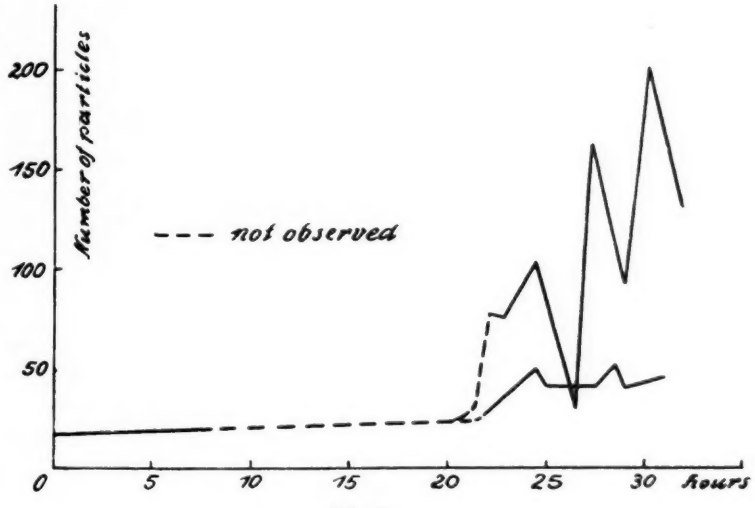

Fig. 9.

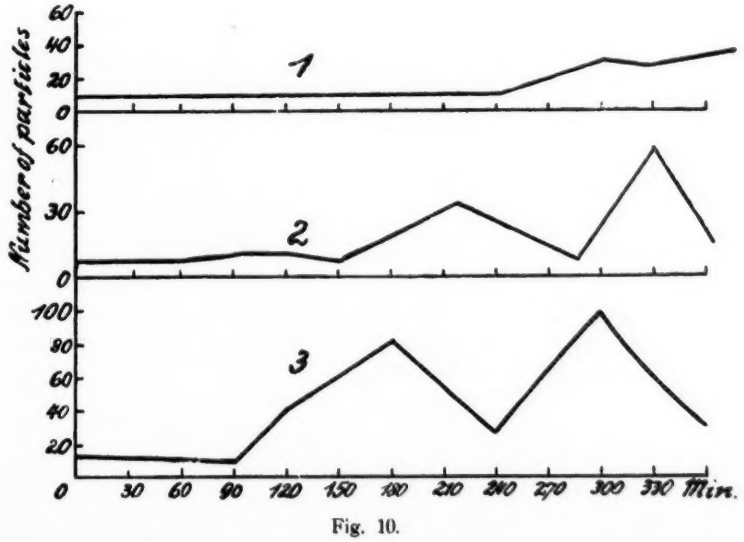

Fig. 10.

periments is as follows: During the whole time the solution is being irradiated, some drops are taken from time to time, and counted. After a period of latency characteristic particles are observed in the microscope, as already described by Nakashima. Their number increases rapidly and at the same time they are enlarged; a maximum is reached, then suddenly there is a decrease in the number of particles down to a minimum. A second maximum and minimum follow and continue in a series. As the irradiation is continued the amplitudes become larger, that is, the difference between the maxima and minima becomes greater. If the pseudoglobulin is replaced by albumen, the same type of reaction is obtained, but the reaction is less, the period of latency greater, and the amplitudes are smaller (Fig. 6). The next experiments consisted in determining the accuracy of the method (Fig. 7). Two solutions of the same kind were irradiated under the same conditions and the curves of the number of particles plotted. The reactions agreed very well and it may be concluded from this and other experiments that the method of counting the protein particles is reliable for skilled experimenters who observe the necessary precautionary measures.

Figure 4 represents the curve of the particles of 0.01 per cent pseudoglobulin

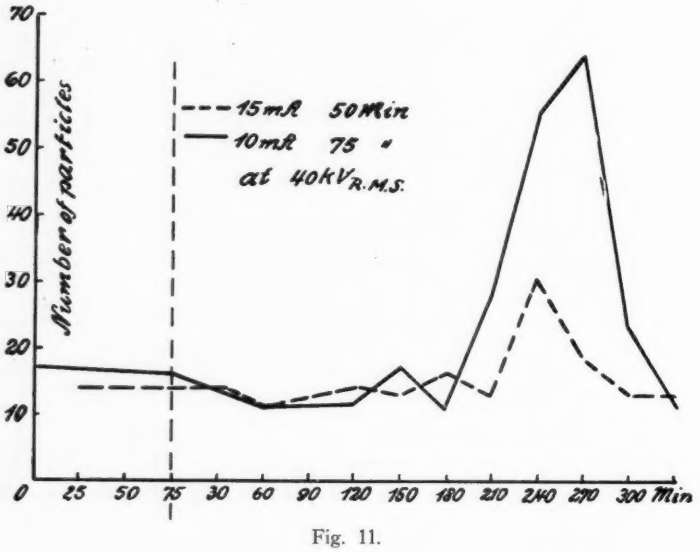

Fig. 11.

formed by irradiating continuously. Figure 8 shows the curve obtained by irradiating first with a certain dose and observing afterwards. As before, the particles appear with periodical amplitudes after a certain period of latency, but now the amplitudes become smaller and smaller as time goes on. The doses used in all these experiments were many times the erythema dose. Figure 9 gives the reaction from a single erythema dose. Here the period of latency amounts to almost twenty hours; then the maxima and minima appear. The control experiment (the dotted line in Figure 9) shows some particles after the period of latency, although the solution was protected by lead. This probably is due to some radiation not absorbed by the lead.

Next the course of the reaction during the irradiation was measured at three different doses (about 1:2:3) (Fig. 10). Increasing the dose gives a decrease of the

period of latency, larger amplitudes, and a lessening of the height of the maxima.

Figure 11 represents the curves for the same dose, but applied differently, one within 50 minutes, the other within 75 minutes. The number of particles was counted after the irradiation. The dose for the longer time gave a larger maximum. The periods of latency are the same, if period of latency is understood to be the period of time from the beginning of the irradiation to the first rise of the curves.

The experiments received an essential extension by the measurements with monochromatic ultra-violet light. This was obtained by analyzing the light of a very strong quartz burner by means of a quartz-spectrograph. Figures 12 and 13 show the behavior of the protein solutions at the wave lengths of 248μμ, 254μμ, 265μμ, 303μμ and 313μμ as examples. First, the type of the curves is the same. Secondly, with increasing wave length, the period of latency becomes longer; that is, a longer period of time elapses before the reaction becomes visible, but the amplitudes increase. This increase follows the course of the absorption; that is, the more the ultra-violet light is absorbed with increasing wave length the greater the reaction of the solution of protein. It follows, therefore, that the discrepancy between the measurements of Hausser and Vahle (9) and those of Sonne (10) can be easily removed (Fig. 14). Without going into details, all wave lengths at which Hausser and Vahle have measured an action occurs, but, at the longer wave lengths, as 303μμ and 313μμ, the periods of latency are much longer. Therefore, Sonne derived the impression, due to his method of defining the period of latency as the time of irradiation necessary to secure an opalescence, that

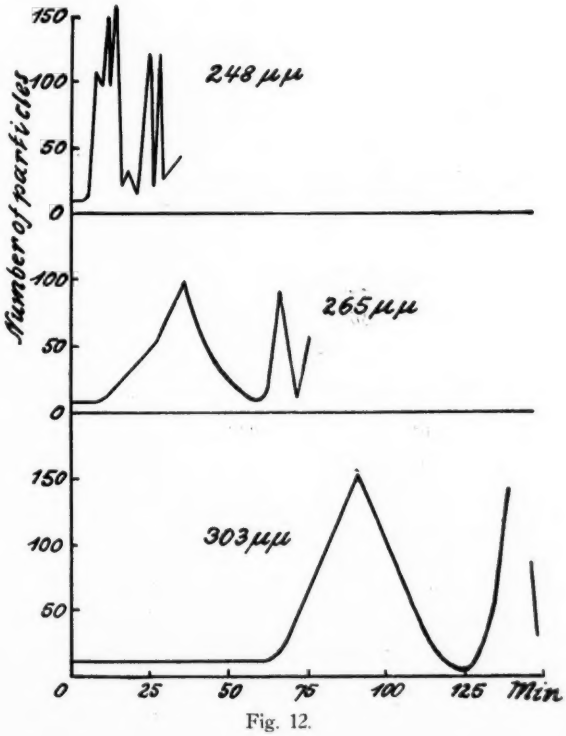

Fig. 12.

there is no action of the ultra-violet light of longer wave lengths, whilst in reality it acts later, but stronger. Figure 15 shows the

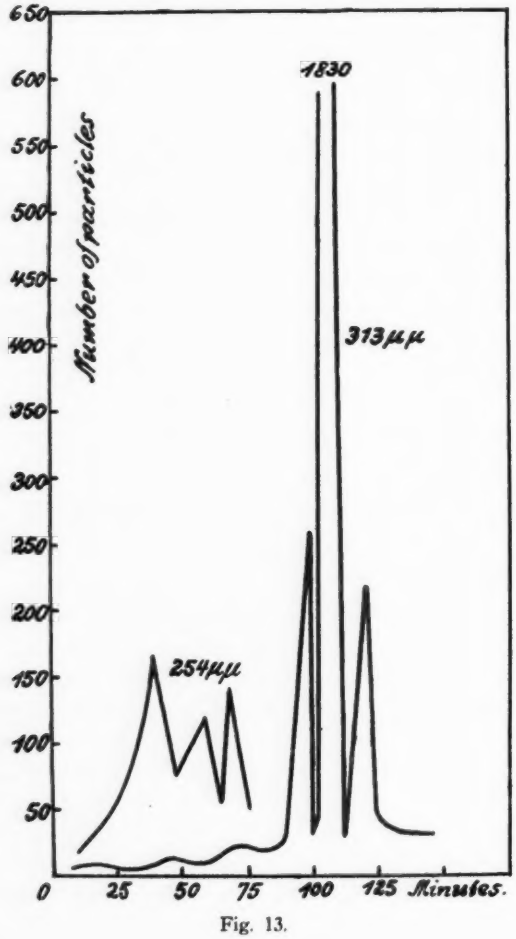

Fig. 13.

results obtained by Hausser and Vahle by comparing the degrees of reddening at different wave lengths with increasing dosage. An arbitrary unit of dosage for each wave length is chosen, which given an erythema defined as "degree of reddening 1."

These curves show that at small doses the reaction is greater, the shorter the wave length, as found by Sonne; but at large doses the effect is reversed, as found by Hausser and Vahle. Both can be explained from our experiments in such a surprising way that one gets the impression that in this reaction we have to deal with the fundamental effect to explain the origin of the erythema. Furthermore, Rajewsky (11), who made these experiments, has solved another important problem. He showed that the reaction of the protein in the ultra-violet could not be specific, produced by a specific wave length, as it seemed to be following the curves of Hausser and Vahle or Sonne. Hausser and Vahle's curves show two well-

defined maxima, and one feels inclined to conclude that they were produced by two specific wave lengths of the ultra-violet. Hausser and Vahle have already pointed out the importance of the transparency of the skin for this effect. As the dotted line in Figure 14 shows, the maxima of the erythema action coincide with the maxima of the transparency of the skin. The curve for the erythema, therefore, is essentially determined by the course of the transparency curve of the skin, but cannot be explained

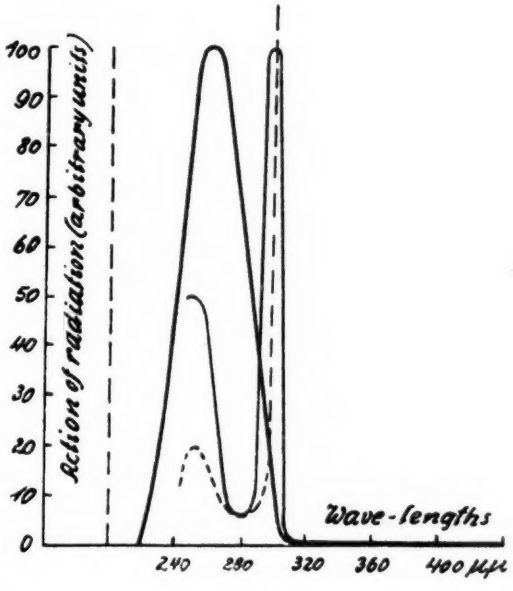

Fig. 14.

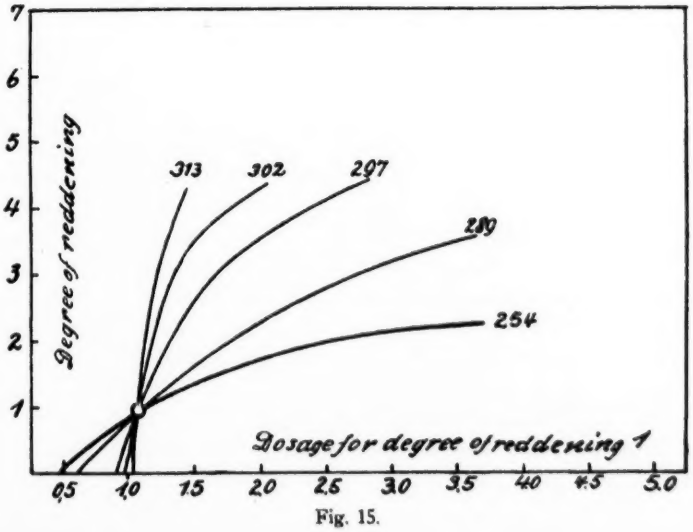

Fig. 15.

by it completely, especially as regards the lesser action of wave lengths of more than 300μμ. The results of the measurements make it obvious that the limit of the reaction producing an erythema lies in this region (300μμ); that is, the amount of energy is

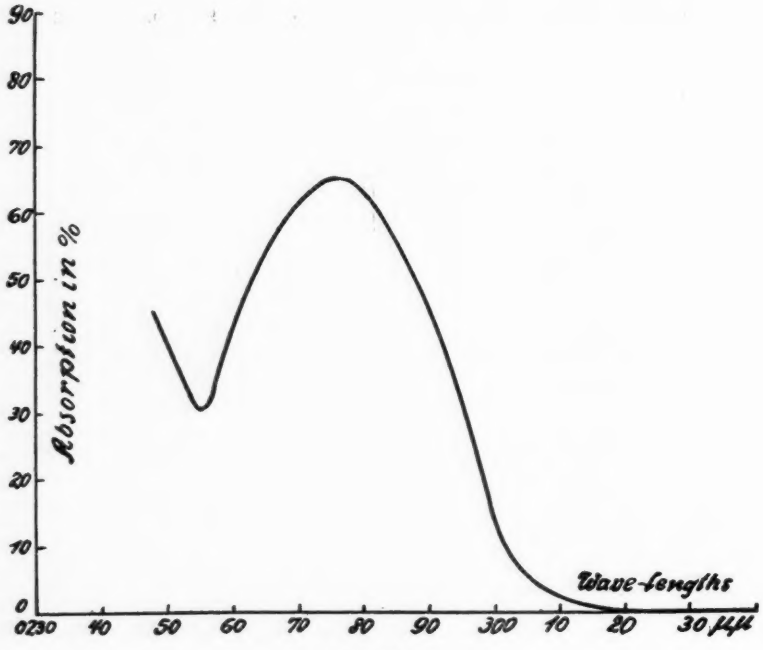

Fig. 16.

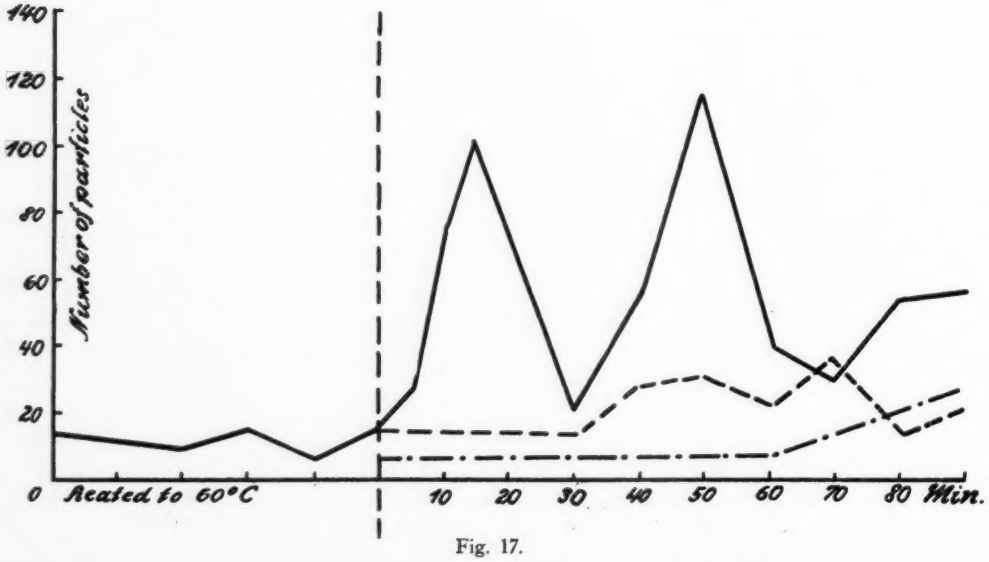

Fig. 17.

insufficient to produce denaturation. Following this assumption and regarding the absorption of radiation in proteins (Fig. 16) as the fundamental reaction, then considering this absorption, a curve is obtained which is analogous to that of Hausser and Vahle (Fig. 14). It can be concluded that the action of radiation begins in the ultra-violet of longer wave lengths.

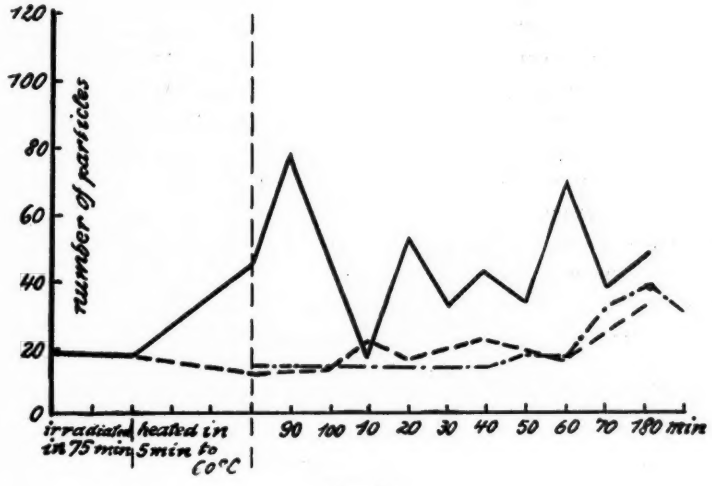

Fig. 18.

It may be mentioned in regard to variation of concentration of hydrogen ions, that an increase of the hydrogen ions is produced not only by irradiation but also by heating the protein solution. This finding will be published in a special paper.

Something still may be said about the fundamental reaction. Is it a non-specific effect, as the hypothesis of the author requires, or a specific one following the photochemical hypothesis? Figure 17 shows the curve of the appearance of particles, if the solution is heated during the irradiation. Figure 18 shows the reaction of a solution first irradiated and then heated. It is known that the genuine photochemical reactions have no essential temperature coefficient; that is, heating does not increase the reactions essentially. But the first curve shows that heating increases the reaction considerably. This is not an addition of the particles formed by heat *and* irradiation, as the control experiments show. The explanation is, rather, that heating brings the molecules into a state of higher energy, and therefore smaller "point heats" cause the reaction. On the other hand, the additional heating of a previously irradiated solution decreases the effect, because here, essentially, the number of collisions producing coagulation is increased afterwards. This experiment proves the non-specific reaction and generally the fact that all these radiations cause the same reaction with all the different proteins. There is no evidence that any specific reaction takes place in all these experiments, but that does not mean that there is no real photochemical reaction of ultra-violet rays. This is also possible, and Gurwitsch's radiation seems to be of this kind. But the general destructive effects of X-rays and ultra-violet rays are founded upon a non-specific process which appears if the transferred energy is sufficient.

The results of this paper are significant

for the reactions in the protein itself. The periodical appearance and disappearance of particles in Brownian movement seem to be general properties of colloidal protein solutions. This fundamental reaction is produced in the same type from the ultra-violet of the wave length 320μμ down to the shortest wave length of X-rays or gamma rays. Quantitatively, the influence of the dosage, the time factor of the dosage, and the period of latency can be examined, and the observed fundamental reaction in the protein will be found to agree in detail with such a complicated effect as the erythema. The results of Nakashima's tests of the analogy of the influence of temperature and radiation are confirmed and considerably refined, showing that neither exerts any specific influence.

REFERENCES

(1) Simonds: First International Congress of Radiology, London, 1925.
(2) Crowther: Proc. Cambr. Phil. Soc., 1926, XXIII, 3.
(3) Holthusen: Strahlentherapie, 1927, XXV, 1.
(4) Fernau: Bioch. Ztschr., 1926, CLXVII, 380.
(5) Fernau and Pauli: Bioch. Ztschr., 1925, LXX, 426, and Koll. Ztschr., 1917, XX, 20, and 1922, XXX, 6.
(6) Wels: Pflueger's Arch., 1923, CXCIX, 226.
(7) Wels and Thiele: Pflueger's Arch., 1925, CCIX, 49.
(8) Nakashima: Strahlentherapie, 1926, XXIV, 1.
(9) Hausser and Vahle: Strahlentherapie, 1928, XXVIII, 25.
(10) Sonne: Strahlentherapie, 1928, XXVIII, 45.
(11) Rajewsky: Strahlentherapie, 1928.

DISCUSSION

Dr. Arthur W. Erskine (Cedar Rapids, Iowa): In the past, investigations made by Dr. Dessauer and his collaborators have always been conducted in the way scientific men work. You will remember, some fifteen years ago, the systematic plan that was adopted and the careful, painstaking methods employed in his study of the distribution of X-rays in water, and you will remember the great value, in a practical way, of that piece of highly technical work. The experiments done by Dr. Shimi and Dr. Rajewsky, in collaboration with Dr. Dessauer, and reported to you just now by Dr. Lorenz, are no exception. They followed, I think, a clearly conceived, systematic plan, and these workers have honestly endeavored to prove or disprove the correctness of Dr. Dessauer's hypothesis. That hypothesis, briefly, is that the destructive effect of X-rays is due to the transformation of their energy into heat at discrete, very small points. The experiments seem to me—and I read the original paper—to support this hypothesis, and, more important, they show that there is a definite relation between the visible effect, as observed in the ultra-microscope, of radiation on the solution of proteins and such a complex biological reaction as the erythema. If this be true, the practical value of this work and of the similar work which will follow it, can hardly be exaggerated.

Dr. Francis Carter Wood (New York City): I have always been very much interested in Prof. Dessauer's point heat theory, and also in the very sharp criticisms of it which have been made by certain workers abroad, and have always regretted that no experimental approach to the problem has as yet been brought forward. I was, therefore, interested in this paper, for it seems, offhand, to give very good support to the notion that these minute centers of high temperature which are theoretically produced by the impact or stoppage of electrons in proteins should give what is equivalent to an extremely high temperature in a very minute space, such as a protein molecule. I have often shown a lantern slide to illustrate the various things that go on in a single molecule when it is hit by a beam of X-ray. Electrons are thrown off, forming, in turn, secondary X-rays. Degenerative radiation, according to the Compton effect, also throws off slow secondary electrons, which form slow secondary X-rays; all these things can occur inside of a single protein molecule. I think that while, off-

hand, the evidence seems to support Prof. Dessauer's theory, we cannot as yet assume that there is final and definite proof. I scarcely would be willing to agree that the ultra-violet experiments, which represent, of course, a molecular and not an atomic action, would confirm an action which is atomic like the X-ray. I should also like to see a very careful repetition, which should be done in Prof. Dessauer's laboratory, of the test on metallic colloids, such as a Bredig platinum colloid. It would not be expected that any slight generation of heat would produce any effect in such a colloid; if it does, we must assume that there are electrical charge differences, and that the ionization effects which occur and which cause coagulation are not necessarily heat effects. I would be glad if Prof. Dessauer would continue this sort of work and show that these same agglutinations can be obtained in purely inorganic colloids. The whole question of temperature coefficient is a very difficult one. There is practically no temperature coefficient in any reaction on live proteins, such as may be observed in killing *Drosophila* eggs. The difference in the temperature reactions in these eggs is slight, and whether the death of these or other cells of the same type follows along the line of these protein coagulations would be very interesting to study. We do know that the first effect of X-ray on *Protozoa* is an immediate increase in the permeability of the membrane, and that the permeability can easily be tested by dyes. There are also minute microscopical changes: the cells become more granular; then in a few hours the protoplasm clears up and the granulation disappears. A good many phenomena observed in such large cells under radiation resemble those described in these protein experiments, but I am afraid that Prof. Dessauer has more work ahead of him to bring convincing proofs of his theory. I had supposed it was entirely beyond proof, but this is the first approach to such a demonstration and I will be very glad to hear further investigations along this line through his very well equipped and highly trained scientific staff.

Dr. Samuel Brown (Cincinnati, O.): I have been very glad to hear this paper, for one reason, because it seems to confirm some of the theoretical ideas of which I spoke to you a year ago and which are published in the current issue of Radiology [Dec., 1928, XI, 466]. One of the things I said at that time is that the force which is used is immaterial—be it heat, light, ultra-violet light, X-ray, or radium—the physical effect will depend on the form of energy used, but the chemical effect, if such takes place, is a function of the substance itself. The more heat a body possesses, the less its resistance, and living tissues, normal or abnormal, are no exception to this rule. At the conclusion I said, "It is the tissue which is highly cellular and therefore of a high heat capacity, which yields so readily to radiation of a certain quantity and not to the quality of radiation." I am very much pleased that some of the experiments done by Prof. Dessauer seem to confirm my conclusions made at that time.

Dr. M. J. Sittenfield (New York City): I am afraid that I, as a student in cancer, find some of this pretty much involved, and I, for one, would like to understand more about this by asking a few questions. There is no doubt but that, under the influence of radiation, there occurs some chemical change within the cell itself. I feel, as Dr. Wood does, that this explains a great part of radiosensitivity; but I wonder if there is not more than this one factor involved in radiosensitivity? We have always heard, and I think we have fair evidence of the fact, that the mitotic state of the cell itself is a large factor in the reaction to the radio-active substances. Fur-

thermore, the state of metabolism or the function of the cell is not unimportant in the problem of radiosensitivity. I would like to ask whether Prof. Dessauer leaves all these out of consideration, or whether he ascribes all of these phenomena as secondary to the point of heat energy.

DR. LORENZ: Of course not; we want to speak only about the fundamental reaction.

DR. SITTENFIELD (resuming): The point I wish to be informed upon is whether a hyperfunctionating cell is more affected by this radiant energy than a cell which is at rest. Moreover, are we to disregard the different phases of cell division, whether the cell is in a state of mitosis or at rest, or are all of these different conditions to be connected up with heat energy?

DR. LORENZ (closing): As I am not a biologist, I cannot answer those questions. Prof. Dessauer's hypothesis is concerned only with the primary reaction which occurs when X-ray quanta are absorbed in the tissue. This fundamental reaction consists, as we think, in the denaturation of the tissue. All subsequent biological reactions are conditioned by this primary physical process. Of course, there must be differences dependent on the state of the cell itself.

Now, regarding what Dr. Wood said, I can say only that the experiments are being continued. I have not been in Frankfort and have not heard from the Frankfort laboratory for the last two months; I do not know what has been done during that time, but I expect that we shall hear of new investigations along this line in the immediate future.

LIMIT EXPOSURE IN RADIOGRAPHY

A SUPPLEMENTARY REPORT

By ERNST A. POHLE, M.D., PH.D., F.A.C.R., Professor of Radiology, and CECIL S. WRIGHT, B.S., M.D., Senior Resident in Radiology, University of Wisconsin Medical School, MADISON, WISCONSIN

TWO years ago, one of us (Pohle) published a brief article under the same title in this Journal (1). At that time, the discrepancy between the so-called American and German r-units still existed. Since then, this question has been adjusted and we are all using the International r-unit. For that reason we have remeasured the data given in the above-mentioned paper and added others, particularly in order to permit a comparison of our results with those of Braun, Hase, and Kuestner (2). These authors undertook a very detailed study of the doses administered in radiography and expressed them in r-units. While we first considered reprinting some of their very practical tables, we decided to modify the compilation in order to adapt it to the American laboratory.

The tables presented by Braun and his coworkers permit the calculation of the number of r-units administered to a patient during a fluoroscopic examination or an exposure while taking a roentgenogram. They emphasize that the figures apply only to the apparatus and tube where they were measured, and suggest, therefore, a safe maximum dose of 100 r-units.[1] Assuming a variation of even 100 per cent in the output of different types of equipment, the total dose would still remain within reasonable limits. We do not have an exact knowledge regarding the output of the various makes of diagnostic apparatus in this country; only recently Bishop and Warren (3) have compared a machine of the mechanically rectified type and one of the valve tube type. As far as the therapy machines are concerned, Meyer and Glasser (4) reported that for deep therapy radiation the highest variation was 45 per cent for transformers with mechanical rectifier and 80 per cent if compared with the kenotron type. The corresponding figure for unfiltered radiation at 100 K.V. reached 160 per cent. It seems reasonable then to suspect at least as much, if not more, fluctuation in the output of diagnostic apparatus which is operated at even lower potentials. Another complicating factor is the difference in the thickness of the glass walls of the tubes. Wucherpfennig (5) has drawn attention to this fact and discussed its importance in superficial therapy. For low potentials and light filtration as used in radiography, the quality and quantity of the emitted radiation is more influenced by that factor than in deep therapy. While in our first study, the diagnostic tube chosen for the tests had approximately the same output as one of the therapy tubes, it was deemed advisable, in view of our present knowledge, to compare a number of diagnostic Coolidge tubes as to their emissions.

EXPERIMENTAL WORK

Two machines were equipped with one and two valve tubes, respectively (no condensers), the other two with mechanical rectifiers of different construction.[2] We used a fairly new air-cooled medium focus Coolidge tube for all measurements. The ionization instruments available were a Duane Standard Ionization Chamber with galvanometer and standard cell (6), a Dessauer Electroscope (7), a Wulf Ionometer,

[1] The value suggested in the first article (1) amounted to approximately 180 International r-units.

[2] We gratefully acknowledge the co-operation of our colleagues, whose kindness made this study possible. Thanks are also due to Miss D. Smith, B.A., for her assistance in carrying out the ionization measurements and in compiling the results.

and a Siemens Dosimeter. The thimble ionization chamber of the latter instrument has the least dependence on the wave length. The drop in the ionization amounts to only 3 per cent at 50 K.V. and 1.0 Al. filter, as compared with 180 K.V. filtered through 2.0 mm. Cu. (8). For most tests, the chambers of the Wulf Ionometer and the Siemens Dosimeter were placed together in the same beam of roentgen rays. A tube current of 5 milliamperes and a distance of 10 inches (25 cm.) were chosen as standard during the measurements. The potential of each machine was recorded as indicated by the kilovoltmeter in the switchboard, because this is in correspondence with the daily working conditions. In some models the meters have arrangements on the scale to compensate for potential drops at higher tube currents. Since we plotted in each case the absorption curve in aluminum, a comparison of the quality of radiation is possible, regardless of the accuracy of the kilovoltmeter on each machine. The prereading kilovoltmeters of both machines with mechanical rectifiers were calibrated by a sphere gap after installation, and in one case (M.R. 1) verified by us at the time of the tests. According to known facts, the sphere gap indicates the potential 10 to 20 per cent higher than found by the spectrographic method.

In Figures 1, 2, and 3, the absorption curves in aluminum for all machines and potentials from 40 K.V. to 80 K.V. are drawn. The abscissa gives the logarithm of the intensity, the ordinate, the filter thickness in millimeters. It is evident that both valve tube machines produced a beam of higher penetration than the two machines with mechanical rectifiers. As no sphere gap measurements were carried out on the valve tube equipment, one might consider that this is partly due to a difference in the readings of their kilovoltmeters.

The quantity tests are compiled in Table I, presenting the number of r-units per second emitted from the same tube, filtered through 0.25, 0.5, and 1.0 mm. of aluminum when connected to the four different machines. The output of the valve tube apparatus is higher than that of the machines with mechanical rectifiers, while the latter two agree more closely. In Column 4 of Table I, the output of another model of the same make of apparatus with mechanical rectifier (M.R. 1), using the same tube, is added in parentheses for 1.0 mm. aluminum filtration. Its output is considerably higher than that of the first model.

Table II demonstrates how much variation may be expected in the emission of different tubes operated on the same trans-

TABLE I.—OUTPUT OF FOUR MACHINES

r per sec. 5 ma. 10 inches (25 cm.) F.D.

	V. 1			V. 2			M.R. 1			M.R. 2			Average		
K.V.	.25	.5	1.0	.25	.5	1.0	.25	.5	1.0	.25	.5	1.0	.25	.5	1.0*
40	.5	.4	.3	—	—	—	.2	.1	.1(.2)**	—	—	—	.4	.3	.2
50	.8	.6	.4	—	—	—	.4	.3	.2(.3)	.4	.3	.2	.6	.4	.3
60	1.1	.9	.6	.9	.7	.5	.6	.5	.3(.5)	.7	.5	.4	.8	.7	.5
70	1.5	1.2	.9	1.2	1.0	.7	1.0	.8	.5(.6)	1.0	.7	.5	1.2	.9	.6
80	2.0	1.6	1.1	1.7	1.3	.9	1.2	1.0	.7(.8)	1.3	1.1	.7	1.5	1.2	.9

*Filter in mm. Al.
**Same make of apparatus as M.R. 1 but different model.

Note.—The decimal was carried out to three places, and then corrected to one place.

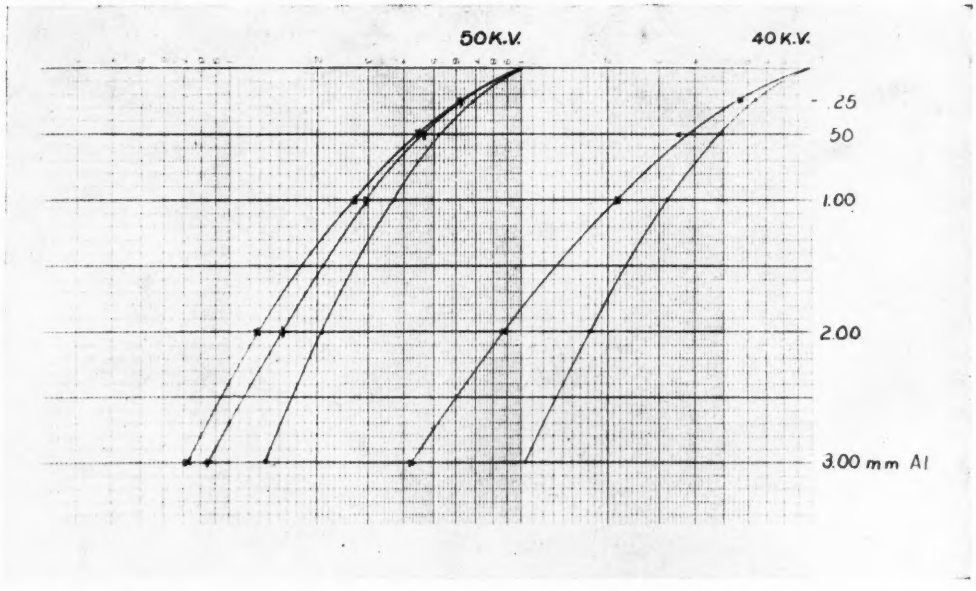

Fig. 1. Absorption curves in aluminum for 40 K.V. and 50 K.V. Valve tube machine, No. 1 (dots), mechanical rectifier machine No. 1 (×), and mechanical rectifier machine, No. 2 (+). Abscissa: log of intensity. Ordinate: filter thickness.

former under equal conditions. In order to balance the difference in the wall thickness, the number of r-units per second is given after filtration through 1.0 mm. aluminum. While it is obvious that the loss in output due to usage requires correction, even new tubes occasionally show enough variation to be of importance.

A number of the most frequent exposures used in diagnostic laboratories are compiled in Table III. The last column offers the number of roentgen units administered to the skin when taking the respective roentgenograms. The values derived by Braun, Hase, and Kuestner, as well as those obtained by actual measurements in another clinic, are added for comparison. For a considerable number of identical exposures, the roentgen energy applied to the skin appears to be in good agreement, notwithstanding the difference in the output of the equipment and in technic. For instance, in the first and third laboratories, filters of aluminum are used throughout the work, while the second laboratory prefers to employ unfiltered radiation. A detailed study

TABLE II.—OUTPUT OF SEVEN TUBES

r per sec. 5 ma. 10 inch (25 cm.) F.D. 1.0 mm. Al.

K.V.	Med. Focus (new)	Med. Focus (used)	10 ma. Radiator (new)	10 ma. Radiator (new)	30 ma. Radiator (new)	30 ma. Radiator (old)	30 ma. Radiator (new)
40	.3	.3	.3	.3	.3	.2	.2
50	.4	.4	.4	.4	.4	.3	.3
60	.6	.6	.6	.6	.6	.5	.5
70	.9	.8	.8	.7	.7	.6	.6
80	1.1	1.1	.9	.9	.9	.7	.8

Note.—The decimal was carried out to three places, and then corrected to one place.

TABLE III.—RADIOGRAPHIC EXPOSURES MEASURED IN r-UNITS

Part	K.V.	Ma.	Filter (mm. Al.)	F.P.D. (inches)	F.S.D. (inches)	Exposure (sec.)	r-units	Remarks
Skull, A-P	78*	15	.5	—	22	9	3.8	With grid
	80	30	0	36	27	6	9.0	With grid
	70	25	1.0	27	19	8	6.4	With grid
Skull, Lat.	78	15	.5	—	23	6	2.3	With grid
	80	30	0	36	28	3	4.3	With grid
	65	25	1.0	27	20	6	3.9	With grid
Spine, Cerv., A-P	67	20	.5	—	23	7	2.8	With grid
	80	30	0	33	26	1	1.7	No grid
	65	25	1.0	27	18	4	3.2	With grid
Spine, Cerv., Lat.	—	—	—	—	—	—	—	—
	80	30	0	33	27	.75	1.1	No grid
	60	25	1.0	27	19	5	3.2	With grid
Spine, Thor., A-P	78	20	.5	—	20	9	6.0	With grid
	80	30	0	36	25	3	5.3	With grid
	70	25	1.0	27	17	5	5.1	With grid
Spine, Thor., Lat.	85	20	.5	—	18	25	24.2	With grid
	80	30	0	36	20	5	13.9	With grid
	70	25	1.0	27	12	11	22.2	With grid
Spine, Lumb., A-P	78	20	.5	—	18	11	9.3	With grid
	80	30	0	36	26	6	10.0	With grid
	70	25	1.0	27	18	8	7.2	With grid
Spine, Lumb., Lat.	85	20	.5	—	16	32.5	38.4	With grid
	80	30	0	36	20	18	50.0	With grid
	75	25	1.0	27	12	20	45.2	With grid
Pelvis	78	20	.5	—	20	11	7.3	With grid
	80	30	0	36	26	6	10.0	With grid
	70	25	1.0	27	18	8	7.2	With grid
Kidneys	67	20	.5	—	14	6	6.9	With grid
	80	30	0	36	26	6	10.0	With grid
	70	25	1.0	27	18	7	6.3	With grid
Gall bladder	67	20	.5	—	14	5.75	6.6	With grid
	70	60	0	36	26	3	7.9	With grid
	70	25	1.0	17	18	7	6.3	With grid
Stomach	113	55	.5	—	18	.3	1.3	With grid
	70	60	0	36	26	1.5	4.0	With grid
	80	25	1.0	25	18	1	1.1	No grid
Pregnancy	106	60	1.0	—	14	9	49.0	With grid
	80	30	0	36	20	8	22.2	With grid
	75	25	1.0	27	12	12	27.2	With grid
Chest (child)	71	50	1.0	—	36	.3	.1	No grid
	80	100	0	72	64	.2	.18	No grid
	80	25	1.0	36	28	.3	.14	No grid
Chest (adult)	99	60	.5	—	72	.45	.1	No grid
	90	100	0	72	62	.1	.12	No grid
	80	80	.25	72	62	.2	.14	No grid

*The first line in each group represents the results of Braun, Hase, and Kuestner, while the second and third are obtained from an American laboratory and our own.

of Table III shows ways and means concerning the development of a technic affording maximum protection for the skin.

Inasmuch as all tests were carried out with the ionization chamber in air, the amount of back-scattering from the patient has not been considered in computing the skin surface doses. For a large field of 100 sq. cm., 80 K.V., 1.0 Al. and 16 inches F.S.D., this did not exceed 20 per cent. The absorption in air has been neglected because it would not amount to more than 10 per cent, and is less, in all probability, for the radiations used in this investigation.

PRACTICAL CONCLUSIONS

When our work was started, we hoped to be able to present average figures serving as guides in radiography to prevent over-exposure. In view of the observed fluctuations, both in apparatus and tubes, great cau-

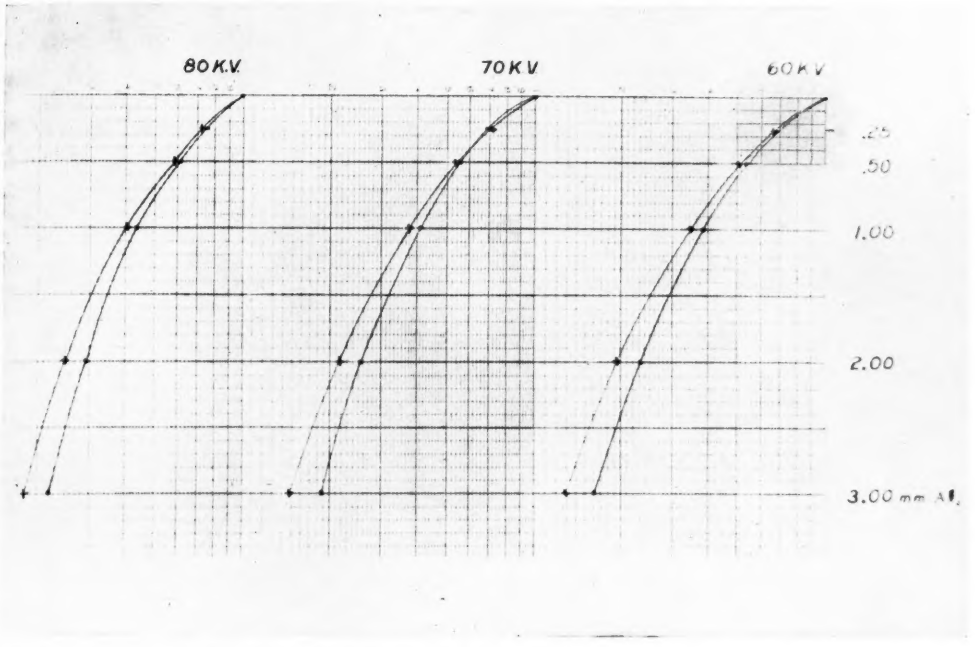

Fig. 2. Absorption curves in aluminum for 60 K.V., 70 K.V., and 80 K.V. Valve tube machine, No. 1 (dots), mechanical rectifier machine, No. 2 (+). Abscissa: log of intensity. Ordinate: filter thickness.

tion has to be exercised in the compilation and use of such figures. We endorse the acceptance of a safe maximum dose of 100 r-units[3] in diagnostic radiology, as suggested by Braun, Hase, and Kuestner (2), because a difference of even 100 per cent in the output of the radiographic equipment would not lead, then, to dangerous doses. With those restrictions in mind, we offer the mean values of the output of four machines tested with the same tube for 0.25, 0.5, and 1.0 mm. aluminum filter for potentials from 40 K.V. to 80 K.V. (see last column, Table I). These figures represent the strength of the beam in r-units per second at 10 inches F.S.D. and 5 ma. tube current. In order to facilitate their use in practice, Tables IV and V give the correction factors for tube currents[4] from 3 ma. to 100 ma. and focal skin distances from 9 inches to 30 inches, most common in radiography, and from 6 inches to 12 inches as used in fluoroscopy. We emphasize that the distances were measured between target and skin and are, therefore, shorter than the distance between target and plate. Two practical examples may illustrate the application of these tables.

1. Roentgenogram of pelvis (A-P): 80 K.V., 0.5 Al., 20 ma., screens and grid, target film distance, 27 inches; time, 5 seconds; F.S.D., 14 inches.
   In Table I, last column: 1.2 r per second.
   In Table IV: factor 2.04 for 20 ma. and 14 inches F.S.D. One film: $1.2 \text{ r} \times 2.04 \times 5 = 12.2 \text{ r}$.
2. Fluoroscopy of chest (P-A): 50 K.V., 1.0 Al., 4 ma., F.S.D., 12 inches; time, 64 seconds.
   In Table I, last column: 0.3 r per second.

[3]This assumes, however, the use of an aluminum filter.

[4]The output of the tubes has been assumed to be directly proportional to the tube current; this does not hold exactly, as actual tests have shown.

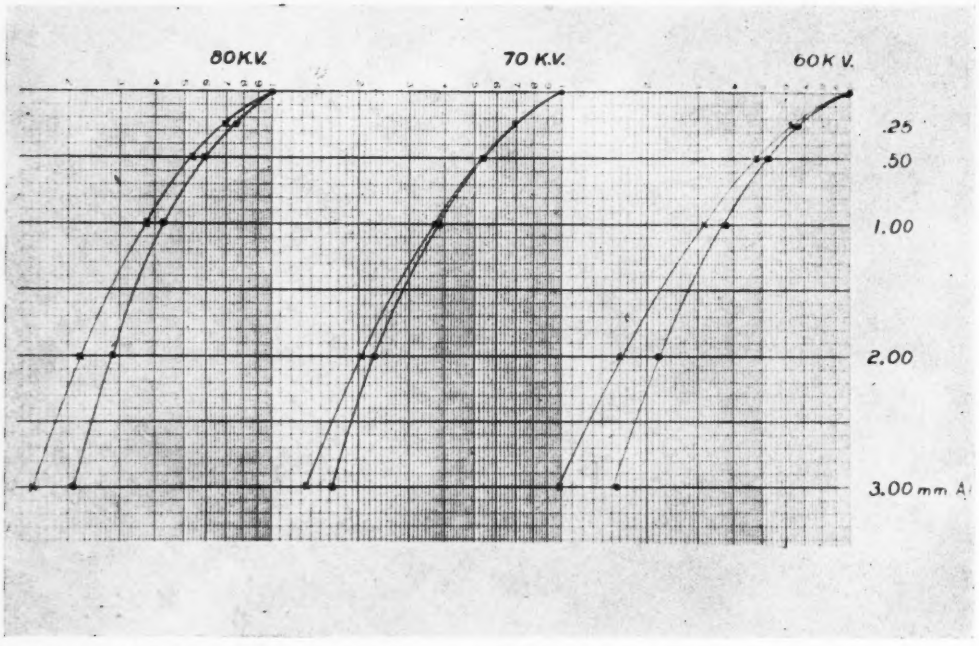

Fig. 3. Absorption curves in aluminum for 60 K.V., 70 K.V., and 80 K.V. Valve tube machine, No. 2 (0), mechanical rectifier machine, No. 1 (×). Abscissa: log of intensity. Ordinate: filter thickness.

In Table V: factor 0.66.

Dose: 0.3 r × 0.66 × 64 = 12.7 r.

A study of Tables I and II demonstrates that any calculation, as carried out above, may contain a considerable error in the neighborhood of ±50 per cent. This is due to the fluctuation in the output of different machines and tubes. Table III offers additional help in computing the maximum number of exposures which can be given before reaching the upper safe limit.

In closing, we wish to emphasize that this study was undertaken to determine how many r-units are administered to the skin when taking a roentgenogram for diagnostic purposes. We were not interested in the comparative speed of different makes of diagnostic apparatus because we feel that good

TABLE IV.—CORRECTION FACTORS FOR RADIOGRAPHIC WORK

F.S.D. in inches	Tube current in ma.						
	10	20	25	30	50	80	100
9	2.47	4.94	6.17	7.41	12.34	19.76	24.7
10	2.0	4.0	5.0	6.0	10.0	16.0	20.0
11	1.65	3.3	4.13	4.96	8.27	13.2	16.54
12	1.39	2.78	3.47	4.17	6.95	11.12	13.9
13	1.18	2.36	2.96	3.54	5.92	9.47	11.84
14	1.02	2.04	2.55	3.06	5.1	8.16	10.2
15	.89	1.78	2.22	2.67	4.45	7.12	8.9
16	.78	1.56	1.95	2.34	3.9	6.24	7.8
17	.69	1.38	1.73	2.07	3.47	5.52	6.94
18	.62	1.24	1.54	1.86	3.09	4.96	6.18
19	.55	1.1	1.38	1.65	2.76	4.4	5.52
20	.5	1.0	1.25	1.5	2.5	4.0	5.0
21	.45	.9	1.13	1.35	2.26	3.6	4.52
22	.41	.82	1.03	1.23	2.07	3.28	4.14
23	.38	.76	.95	1.14	1.9	3.04	3.8
24	.35	.7	.86	1.04	1.73	2.8	3.46
25	.32	.64	.8	.96	1.6	2.56	3.2
26	.3	.60	.75	.9	1.5	2.4	3.0
27	.27	.54	.68	.81	1.37	2.10	2.74
28	.26	.52	.64	.77	1.28	2.05	2.56
29	.24	.48	.59	.72	1.19	1.90	2.38
30	.22	.44	.55	.66	1.11	1.76	2.2

TABLE V.—CORRECTION FACTORS FOR FLUOROSCOPIC WORK

F.S.D. in inches	Tube current in ma.		
	3	4	5
6	1.67	2.22	2.78
8	.94	1.25	1.56
10	.6	.8	1.
12	.5	.66	.83

results can be obtained with any well built unit. There are certain advantages and disadvantages in each type and, in the last analysis, the selection of equipment is probably more or less a matter of choice of the individual roentgenologist. Besides that, an accurate comparison of the so-called speed of radiographic apparatus is difficult and requires a different experimental arrangement than used in this investigation. In our opinion, that technic should be given the preference which permits of obtaining a good roentgenogram by applying the minimum dose to the skin.

SUMMARY

1. Four radiographic machines, using the same tube, were calibrated in r-units, under conditions existing in practice.

2. The emissions of seven diagnostic Coolidge tubes of different types and ages were measured in r-units, when connected to the same apparatus under identical operating conditions.

3. The approximate number of r-units applied to the skin was determined for a group of diagnostic exposures. Data from three different laboratories are presented.

4. Tables with correction factors have been compiled, which, in connection with the mean values of the output of the four machines, permit the calculation of the approximate doses used in radiography. The possible error for such a compilation is estimated at ± 50 per cent.

BIBLIOGRAPHY

(1) POHLE, E. A.: RADIOLOGY, 1927, IX, 65.

(2) BRAUN, R., HASE, H., and KUESTNER, H.: Fortschr. a. d. Geb. d. Roentgenstr., 1928, XXXVIII, 385.

(3) BISHOP, F. W., and WARREN, S. L.: Am. Jour. Roentgenol. and Rad. Ther., 1929, XXI, 229.

(4) MEYER, W. H., and GLASSER, O.: RADIOLOGY, 1926, VI, 320.

(5) WUCHERPFENNIG, V.: Strahlentherapie, 1928, XXVII, 353.

(6) DUANE, W., and LORENZ, E.: Am. Jour. Roentgenol. and Rad. Ther., 1928, XIX, 461.

(7) POHLE, E. A., and BARNES, J. M.: RADIOLOGY, 1928, X, 300.

EDUCATION AND INSTRUCTION IN ROENTGENOLOGY[1]

By WILLIAM H. MEYER, M.D., Director X-ray Department, New York Post-graduate Medical School and Hospital, NEW YORK CITY

TO introduce the presentations of the evening I have taken as my subject "Education and Instruction in Roentgenology," feeling that here is a topic of immediate interest to us all. The title may be somewhat misleading as to its intent, since "education and instruction in roentgenology" applies not alone to the roentgenologist, the fact being that enlightenment is required in many other directions.

The need of under-graduate instruction requires as much consideration as post-graduate. Furthermore, there is but little doubt that hospital executives and boards require much authentic information concerning our aims and needs so that there may be better understanding and more co-operative regulation. The lay public also requires education so as to correct some of its ill-conceived ideas concerning the modalities and significance of roentgen diagnosis and therapy. The manufacturers' and salesmen's ideas might also be subject to some revision or regulation, to say nothing of the ever-variable legal aspect brought about by the more common use of radiant energy.

Remarkable as the advancement of roentgenology has been since the discovery of the X-rays thirty-three years ago, most of us know that we are but at the threshold of development as regards both the methods of application and means of interpretation; therefore, none of us is exempt from further learning.

Of the roentgenologist of to-day is required no mean knowledge of the electronic theory, electrophysics, mathematics, photography, etc., if the control of his equipment is to be on an intelligent and satisfactory basis.

Interpretation begins with the application of the physical factors involved, in which the laws of light, divergence, distortion, and absorption, as well as hydrostatics and gravity, play important rôles. Interpretation continues with the avoidance of misinterpretation of normal variations, requiring a thorough study, not alone of normal roentgen antomy but of development as well.

The roentgen aspect of physiological function has its own peculiar application, especially in the study of intrathoracic and abdominal lesions. Correct interpretation in conjunction with the foregoing data being finally dependent upon gross pathological change, a careful review of clinical, operative, biopsy, and autopsy findings rounds out the fund of knowledge required.

With regard to pathological data, the roentgenologist's viewpoint is not always fully comprehended. The latter rarely knows aught of color, consistency, cell type, or organisms represented in a given lesion. Furthermore, immediate ante- or postmortem changes may have added to the findings conditions that previously did not exist. Again, excepting in a confirmatory way, microscopy is of but little direct value in roentgen interpretation, for what cannot be determined by gross pathological examination can hardly be discovered by means of the X-ray. Notwithstanding this the trained roentgenologist, by careful analysis, often draws conclusions which are only finally verified by microscopic examination. The foregoing emphasizes the importance of experience, that all-important teacher requiring time, patience, study, and many a hard knock, ere reasonable proficiency is attained.

The extent of knowledge and degree of proficiency determine the standing of the roentgenologist of to-day. Without a thorough basic foundation as above outlined, without training and years of hospital ex-

[1]Read at the 1929 reunion of the students and associates of the Department of Roentgenology at the New York Post-graduate Medical School and Hospital, June 5th.

perience, no man should be accredited as expert in his line, be that roentgenology or any other specialty, and steps should be taken to protect the public from the incompetent or lay radiologists, commercial or other laboratories, even if there be a figurehead M.D. in evidence.

Because of the complex requirements as well as because of the danger involved, the operation of X-ray machines for diagnosis and treatment should be legally limited to those with proper credentials; only thus can the best results in roentgenology be obtained.

I fully realize that there are many, almost insurmountable difficulties in elevating radiology to its proper plane.

One of the fundamental difficulties of to-day is that the basic principles of roentgenologic technic, interpretation, and therapy are not receiving sufficient consideration in the under-graduate school. With indifferent instruction in the modalities and possibilities as well as the shortcomings of roentgenology, the under-graduate as well as the graduate has often a false concept, resulting in the most pitiful misunderstanding—to the sorrow and chagrin of the trained roentgenologist.

It is high time that the under-graduate schools should introduce into their curricula at least short courses, given by competent and understanding men, in the fundamentals of roentgen interpretation based upon sound physicopathologic principles, so that students may have a better concept of pathologic conditions, which, by their variation in structural density, produce certain shadow variations. Lay the right foundation in the under-graduate school of to-day and much of the misunderstanding and many of the false concepts will fade to-morrow.

Because of present-day negligence in the under-graduate schools, certain under-graduate methods of instruction have become necessary in the post-graduate teaching of radiology. This often creates a most difficult situation, since many of the older men in practice are unwilling to admit the complexities of this relatively new and rapidly developing specialty.

Another serious matter is the fact that any one may purchase X-ray equipment. The manufacturer is, of course, interested in quantity production and financial return. Catchy advertisements and clever salesmanship, simple push buttons and quick installations, the lure of a big show and easy money are sometimes hard to resist.

If legal means cannot be introduced to remedy these evils, there is still the possibility of public education, wherein each of you, trained and experienced in your line of work, shall become disciples of the truth as herein described.

There are many other directions in which enlightenment and education in matters roentgenological are required. Difficult questions often arise because of close interdepartmental relations, touching not alone upon methods of departmental control but upon hospital management, executives, and administrative boards.

For example, questions relative to the ownership of plates or films. The rules governing our X-ray Department appear at times to cause inconvenience, since there is variance of opinion with respect to the ownership of the products of X-ray exposures.

It is true that in roentgen interpretation photographic materials are employed; these, however, are in no sense of the word *pictures*. A series of exposures, exactly like a series of clinical or laboratory tests, are employed to study a symptom-complex. Furthermore, exposures in themselves often do not represent 50 per cent of the means employed in interpretation, as, for example, a fluoroscopic examination may be a complementary procedure, the records of which are kept in writing. It is not presumption to state that training and experience are necessary for the proper application and in-

terpretation of roentgen findings; whether these be radiographic or fluoroscopic is immaterial.

Approaching the matter from another angle, the fluoroscopic data and exposures form a part of the examination as much as a chemical analysis, blood examination, or biopsy, and are, therefore, a part of the records of the case and should remain on file in the institution, as does the chart. I might add further that exposures and records are subject to subpœna and must, therefore, remain on file for a given number of years.

Another matter, not to be forgotten with respect to this institution in particular, is that the ravaging of our files by individuals would interfere very materially from a pedagogic standpoint with their use for research and teaching purposes.

Further, I wish to state that this is not a commercial laboratory, selling pictures. We are giving interpretations, opinions, and, in consultation, diagnosis, as should be the case with any roentgenologist of repute.

The following factors have to do with the installation of X-ray equipment outside of the control of the X-ray Department, with resultant difficulties in administration, operation, and control. This practice also leads to further questions on matters of interpretation and pedagogy.

Thus, Where and how shall instruction in roentgenology be conducted? The following paragraphs represent the roentgenologist's viewpoint.

Is it not unquestionable that it is to the best interests of the patient and all concerned that any diagnostic or therapeutic procedure be conducted by those most expert in their particular branch or specialty?

In a teaching institution should not work requiring special technical skill and training as well as interpretative ability and experience be concentrated in one department under proper supervision, so that satisfactory instruction in that particular branch may be given?

As far as laboratory installation and operation of X-ray equipment are concerned, in New York a permit is required from the Board of Health as well as a certificate from the County Medical Society, which permits are granted presumably upon the knowledge and experience of the operator and his compliance with the requirements as to type of installation, protection, etc. The strange thing is that no such supervision or regulation applies to the private installation of mediocre type, often under inefficient management.

The determination of finer detail and interpretation of smaller infiltrative lesions is practically impossible by means of fluoroscopy. In this respect fluoroscopy is but a supplementary procedure affording a means of studying expansion, aëration, mobility, and pulsation. Though gross lesions may be determinable, authentic records for future comparative purposes are lacking when fluoroscopy alone is employed.

Before discussing or formulating a scheme for proper conduct and instruction in roentgenology, either independent of or in conjunction with the various other specialties, a few fundamental principles must be recognized, and, if possible, a definite policy established.

In an institution of medium size where many small subdivisions of the specialties are represented, a centralized X-ray department would appear the only economically feasible policy. Should expansion be such that any single specialty, with a separate division or building of two hundred beds or more of its own, could support an independent X-ray laboratory under the supervision of an expert, well and good. On the other hand, if instruction in roentgenology is to continue satisfactorily, then the present trend of installing separate X-ray units in other departments, operated under mediocre

conditions, must cease. Only in a centralized plant can either control or teaching be successfully accomplished.

Though a physician's license may legalize any diagnostic or therapeutic procedure he may choose to employ, does this admit that he is capable in either a technical, diagnostic, or therapeutic way so far as many procedures are concerned, and this, especially, with regard to roentgenology?

In review, the results of decentralization are:

(1) Unnecessary and expensive duplication with—usually—mediocre and unsatisfactory types of apparatus.

(2) Uncontrolled and therefore dangerous and inefficient technic.

(3) Inexperienced and therefore doubtful or erroneous interpretation.

(4) Centralized filing becomes difficult if not impossible with failure of proper recording and cross-indexing.

(5) Teaching becomes disrupted, scattered, and inefficient.

(6) Loss of prestige would mean less work and loss of income.

(7) Incentive to unbiased interpretation and co-operative research is destroyed and the tendency toward improper personal aggrandizement fostered.

Roentgenology has assumed so important a place in the practice of medicine that in most of the newer hospitals more suitable space is being provided, but especially in a teaching institution is a centralized X-ray department essential, with ample provision for properly equipped demonstration rooms.

It is also no more than just that excess income over expenditure from matriculates and private patients should be placed at the disposal of the department for necessary re-equipment, research, and advancement.

A summary of the subjects considered under education and instruction in roentgenology is as follows:

1. The need of proper under-graduate instruction in roentgenology.

2. Enlightenment of the general practitioner as to the possibilities as well as the shortcomings of roentgen interpretation and therapy.

3. The rather extensive experience and complex requirements of the roentgenologist.

4. The importance of physical factors in both roentgen interpretation and technic are mentioned.

5. Interpretation should be as nearly as possible in terms of gross pathology and though in many instances the roentgen evidence may be absolute and irrefutable, yet negative roentgen findings will fail to nullify positive clinical, laboratory, operative, or biopsy data.

6. The practice of roentgenology in any or all of its branches should be legally limited to those with proper credentials in knowledge, training, and experience, thereby protecting the public from the unscrupulous.

7. The inherent danger and possible errors of interpretation arising from improper technic or employing a single modality such as fluoroscopy has been described.

8. The close relation of the Department of Roentgenology with other specialties is duly considered, suggesting the need of closest co-operation and understanding.

9. The importance of establishing a policy of centralization, especially in a teaching institution, is discussed at length.

In conclusion, as roentgenologists let us by continued application and advancement attempt to minimize misunderstanding; and while striving for high ideals not become discouraged, but ever consider our work a most important adjunct to the practice of medicine, and, as such, a sacred trust.

FUNDAMENTALS OF ROENTGEN-RAY TREATMENT[1]

By H. J. ULLMANN, M.D., Director, Department of Cancer Research, Santa Barbara Cottage Hospital, SANTA BARBARA, CALIFORNIA

IT is eight years since I showed the necessity of measuring the voltage used in roentgenotherapy by a more accurate method than the point gap (1). The point gap had already been abandoned by engineers for measuring voltages over 30,000 (2). Markley (3) in 1926 again emphasized the necessity of accurate voltage measurement. In spite of this, articles are continually being written with the quality of radiation expressed in "inches gap." This is especially true of papers written by or for dermatologists. It is hoped that the data and tables given in this paper will assist not only the radiologists but the dermatologists to make their roentgen dosage more accurate, for it is only by so doing that we may be able to evaluate results.

There are six factors involved in formulating a dose of roentgen rays. Some may be combined, such as voltage and filter when expressed as wave length, and milliamperage and time when expressed in roentgen, or r, units. These factors are voltage, milliamperage, time, distance, filter, and port, or area of surface irradiated. The voltage and filter determine both the quality and quantity of the radiation; the milliamperage the intensity, and when multiplied by the time becomes quantity. The quantity also depends upon the other two factors, distance and port.

The necessity of using the term "volt" or its multiple, "the kilovolt," instead of "inches gap" has been demonstrated and the arguments will not be repeated. There is, however, an important error which is being copied and carried on from paper to paper and from book to book, the importance of which fortunately varies and is least within the range of voltage where it is most used. This error is the assumption that, because the quantity of radiation is proportional to the square of the voltage when a direct, constant current is employed, it will be proportional when the current is a pulsating direct one, such as is supplied by the rectifying switch or valve tube without a condenser system. That this relation does not necessarily hold with a pulsating current is well known to physicists. The relation of voltage to quantity varies with different voltages and different machines. It is markedly affected by the wave shape of the current. To demonstrate this a number of observations were made with an ionization chamber and electroscope calibrated in r-units and the results tabulated in Table I. No filter was used. All factors except the voltage are constants. The readings at 100 K.V.P. were used as the base to calculate the dose proportional to K.V.P.[2] The figures represent the equivalent time required to give equal doses.

TABLE I

IONIZATION CHAMBER IN AIR

K.V.P.	Calculated	Measured	Percentage of error in calculated values
30	1150	1800	—12.5
90	124	122	+ 1.6
100	100	100	0
105	91	93	— 2.1
120	69.5	75	— 7.3
125	64	72	—11
CHAMBER ON PARAFFIN BLOCK			
202 SQ. CM. PORT			
58	297.5	360	—17.5
65	237	265	—10.5
90	124	120	+ 3
100	100	100	0
105	91	89	+ 2.25
120	69.5	73	— 4.25

There is so slight a difference in the range from 90 to 105 kilovolts that it falls within the possibility of experimental error. Such a slight error, if actually existing,

[1]Read before the Section on Radiology, American Medical Association, Portland, July, 1929.

could not be demonstrated in skin effects. A difference of 10 per cent or more must not be ignored, so that one cannot use the voltage square ratio above or below these voltages without danger. An entirely different set of ratios might be found if a different set of rectifiers were tested.

Quantity varies with size of port. This is well known and tables of these differences are available for high voltage heavily filtered radiation. A warning to reduce the dose when large areas are irradiated has generally been considered sufficient in formulæ for superficial therapy.

Table II was made to determine how much the dose must be changed for different areas. The method of measuring was the same as that used for determining the voltage relation. The instrument was made by the Victoreen Instrument Company and is calibrated in the International r-unit. The ionization chamber was depressed one-half its diameter in the surface of a large paraffin block as the back-scattering medium. It was found that with an area of 2.5 cm. (1 inch) square, or less, back-scattering could be ignored, as it showed the same intensity as when readings were made with the chamber suspended in air. The intensity of such a small area was therefore taken as 100.

TABLE II

AT 90 K.V.P.

Port in sq. cm.	Time for equal dose
4.5	100
16.0	91
28.0	89
64.0	86
202.0	83

In these measurements 90 K.V.P. was used for the reason that I have used it as a standard in superficial therapy for the last eight years. This voltage, when tested against blunt points at sea level, will give a spark-over from 5¾ to 6⅛ inches, depending upon atmospheric conditions, and when substituted for the six-inch gap in the arithmetical formula advised by MacKee in the first edition of his book, "X-rays and Radium in the Treatment of Diseases of the Skin," worked out as exactly as could be determined by Sabouraud and Noire pastilles and epilation of scalp hair. When tested by the standardized instrument on the paraffin block to include back-scattering, one unit was found to be 320 r. One and one-fourth unit, or erythema dose, unfiltered, is, therefore, 400 r, as stated by Chamberlain and Newell (4). It must be understood that all r-units referred to in this paper were, unless otherwise specified, measured on paraffin, and therefore include back-scattering, *i.e.*, the total dose received by the skin. The arithmetical formula, one of the most important and useful aids in calculating unfiltered dosage, is, therefore, perfectly safe within a narrow range (90 to 105) of kilovoltage. The factor, voltage square, is safe when one has determined the unit dose at 90 or 100 kilovolts, for if one calculates from this in order to use 58 kilovolts, for instance, he will be 17 per cent short of the full dose—a large margin of safety. But if the unit dose has been worked out by skin reactions at 65 kilovolts and calculations are made to substitute 100, one will find, by calculation, that the time should be reduced to 42.5 per cent, when it actually should be 38 per cent, a 12 per cent over-dose. While not large, it might make the difference between temporary and permanent epilation on a sensitive blonde. It is, therefore, safer to use a single voltage for skin therapy unless an accurate, standardized instrument is available.

It is not necessary to measure dosage with an ionization chamber, nor is it practicable for the majority of radiologists or dermatologists using roentgenotherapy to do so, but it is absolutely necessary for accuracy of dosage and safety of patient that any physician using the roentgen ray for

therapeutic purposes measure the voltage with a sphere gap or have his machine calibrated in kilovolts by the manufacturer. It is necessary that he have two milliammeters in series; that he test out small areas of skin for the erythema dose as recommended by MacKee, reducing this dose for larger areas as given in Table II. This is necessary, as even machines of the same make operating with the same tube may vary in output as much as 9 per cent at the same meter readings, and there is a marked difference in output from different tubes due to variations in the thickness of the glass. It is necessary that he always use the same voltage; that he measure his focal skin distance accurately, and that he record on the patient's chart all six factors at each treatment. Much argument could be developed in a court of law over the meaning of a record which showed only that one more or less unit had been given on a certain date.

As it is necessary to use filters to shorten the average wave length when effects are desired on tissues beneath the skin, a series of measurements have been made at different voltages, filters, and ports.

TABLE III

F.S.D. 30 CM.

K.V.P.	Filter in mm. of Al.	Port sq. cm.	r-units per minute at 5 milliamperes
100	1.04	202	63.3
100	1.04	64	57.3
120	1.04	202	92.0
120	1.04	64	84.4
120	3.12	202	49.8
120	3.12	64	46.0
120	4.17	202	40.0
120	4.17	64	37.0
125	3.12	202	54.28
125	3.12	64	47.5
125	4.17	202	45.0
125	4.17	64	40.0

If 400 r-units (with back-scattering) are taken as the minimum erythema dose for low voltage and light filtration, *i.e.*, intermediate wave lengths, it is seen from this table that with 125 K.V.P., 5 milliamperes, 30 cm. F.S.D., 4 mm. of aluminum as filter, and a 64 sq. cm. port, such a dose would be given in 10 minutes. Such a dose will produce a light erythema in some individuals but not in others, and in most cases can be increased 25 per cent (to 500 r) or more with safety. A dose of more than 500 r of such a wave length should not be given by an inexperienced physician, although usually safe for the experienced radiologist. It is always dangerous to give more than 400 r to an area larger than 150 sq. cm. and rarely necessary. The safe dose for other distances may be obtained from the table by the inverse square law, *i.e.*, the time is inversely proportional to the square of the distance, all other factors being the same.

It is frequently of importance to be able to estimate the amount of the depth dose in superficial radiation so as not to over-irradiate underlying tissue. Table IV is the result of measurements to determine such depth dosage. Paraffin has less resistance to the roentgen ray than muscle, so beef was used for this purpose.

TABLE IV

K.V.P.	Filter mm. of Al.	F.S.D. cm.	Port sq. cm.	Percentage of surface dose sq. cm. depth
105	0	26	11.4	12
120	3.11	30	64	53
125	3.11	30	64	53
125	4.15	26	45	50
125	4.15	30	64	59

This table illustrates the marked effect of filtration and distance on the depth dose, other factors being constant.

For high voltage, heavily filtered radiation the factors involved are the same except that a larger dose in r-units is required to produce a skin reaction and the depth dose becomes of prime importance. With this, as with superficial therapy, it is not necessary to test the quantity of radiation with an ionization chamber. It is absolutely necessary, however, to have a sphere gap as part of the installation. Fortunately

Packard (5) has found that the dose of roentgen rays necessary to kill the eggs of the fruit fly *(Drosophila)* is that required to produce a light erythema on a large proportion of individuals and full directions for standardizing dosage by this method have been given by Wood (6). The number of r-units represented by this dose is about 800, including back-scattering, and about 500 measured in air. I have for convenience called such an amount a 100 per cent dose and found that with my machine it will be obtained at 200 K.V.P., 50 cm. F.S.D., 0.5 mm. of Cu. and 1 mm. of Al. filter and a 24 × 24 cm. port with 300 milliampere minutes. A reaction severe enough to produce blistering is not usual under 130 to 140 per cent of this amount. In dividing the dose I found it safe to assume that there is a loss in effect of 7 per cent per day, but it must be understood that the accumulation is not allowed to go above this 100 per cent.

The time allotted to this paper is too short to discuss depth dose and technic of cross-firing. Such information is available in text-books and the literature and the necessity of taking the order of ports into consideration when formulating a treatment has been shown in a recent article (7).

Measurements were made to determine the relation between size of port and time required to reach a standard dose. The method was the same as used for unfiltered rays. The factors were those of the standard settings given for 200 K.V.P. These relations are shown in Table V. A 24 × 24 cm. port is taken as unity and the increase of time required to attain the same dose is shown after each smaller port. The depth dose at 10 cm. in paraffin is also shown.

TABLE V

Port cm.	Time	Depth dose at 10 cm. F.S.D. 50 cm.	F.S.D. 71 cm.
24 x 24	1		53
18 x 18	1.08	45.6	50
12 x 12	1.13	41.3	
9 x 9	1.26	36.3	

The depth dose in paraffin is somewhat higher than that in tissue but is useful for comparing ports. The time required to administer a given dose at 71 cm. is twice that at 50, other factors being the same.

As with superficial therapy, the dose recommended as a standard may be exceeded safely in many instances by an experienced radiologist and is given solely as a safe starting point for the beginner.

The formulation of dosage for so-called deep therapy is much more complicated than for the superficial. A few points only have been stressed and the physician before entering the practice of short wave roentgenotherapy must study the latest texts and become familiar with all the factors involved. Such tables as have been given are guides only and neither complete nor final. They are, however, believed to be safe and have stood the test of use.

REFERENCES

(1) Ullmann, H. J.: The Practical Application of the Sphere Gap to Roentgenotherapy. Am. Jour. Roentgenol., April, 1921, VIII, 195.

(2) Chubb, L. W., and Fortescue, C.: Calibration of the Sphere Gap Voltmeter. Jour. Am. Inst. Elec. Eng., February, 1913 p. 627.

(3) Markley, A. J.: Arch. Dermat. and Syph., December, 1926, XIV, 704.

(4) Chamberlain, W. E., and Newell, R. R.: Epilation and Erythema Dose: Comparison of Filtered and Unfiltered Roentgen Ray. Radiology, April, 1928, X, 280.

(5) Packard, Charles: Measurement of Quantitative Biological Effects of X-rays. Jour. Cancer Res., October, 1926, X, 319.

(6) Wood, Francis Carter: A Biological Ionization Chamber. Radiology, June, 1929, XII, 461.

(7) Ullmann, H. J.: Relation of Fractional to Depth Dose. Am. Jour. Roentgenol. and Rad. Ther., February, 1929, XXI, 174.

THE DIFFERENTIAL DIAGNOSIS OF SYPHILITIC DISEASE OF THE VISCERA[1]

By PROF. DR. FRANZ M. GROEDEL, Bad-Nauheim, Germany

SYPHILITIC disease of the viscera is not as rare as is generally supposed. In the secondary stage of syphilis only minor manifestations occur in the viscera, about which not much is known. They are unimportant from a therapeutic standpoint, because the treatment coincides with the treatment of the infection.

In the tertiary stage of syphilis, the affections of the viscera are much more prominent and chronic. They are often overlooked, and may remain undetected for years. Frequently severe and marked symptoms, due to this disease, remain undiagnosed and untreated, thus endangering life. There is but little in the literature regarding the tertiary stage of the disease in the viscera.

The differential diagnosis of syphilitic disease of the viscera seems to be particularly difficult. As I see it now, I fear that I have overlooked many cases in the past. I desire to state at the outset that it is absolutely necessary, if there exists a suspicion regarding syphilitic disease of the internal organs, not to attach too much importance to the result of the Wassermann test. It is astonishing how often this test remains negative in such cases, even under specific treatment, and very often it becomes positive only after one or two years of specific treatment.

I desire to show that the roentgenogram is a most important aid in the differential diagnosis, and will, therefore, try to demonstrate the most characteristic roentgen signs of the various syphilitic diseases of the viscera.

I will begin with syphilitic disease of the circulatory system. This subject has been studied longest, and is at present best known, but, even so, there are many different opinions expressed in the literature in regard to the differential diagnostic symptoms.

SYPHILITIC AORTITIS

This is particularly the case in regard to syphilitic aortitis. By comparing ordinary cases of syphilitic aortitis with uncomplicated cases of scleroses of the aorta, we will find characteristic differences.

SCLEROTIC CHANGES OF THE AORTA

The X-ray film of the sclerotic aorta shows, first of all, an elongated vessel. This is to be seen in the very prominent arch of the aorta and in the curved shadow of the descending aorta. Generally, but not always and in a markedly varying degree, the aorta is at the same time enlarged, especially the ascending part. Furthermore, the shadow of the aorta is very dense—denser than normal. Because of this, the different parts of the thoracic aorta are easily distinguished and differentiated. At the same time, the margin of the shadow of the different parts of the aorta is very sharp, distinctly and sharply outlined, particularly if there are calcific deposits.

CASE REPORTS

Case 1.—Male, 47 years old; never been seriously ill; recently had an attack of angina pectoris. Sounds of heart feeble. Blood pressure low. The outline of the heart is flabby, the aorta elongated, and the arch very prominent. All parts of the aorta are very easily made out.

Case 2.—Male, 68 years old. History of no importance. Systolic murmur over the

[1]Read before the Radiological Society of North America, at the Thirteenth Annual Meeting, at New Orleans, Nov. 28–Dec. 2, 1927.

sternum. Blood pressure slightly increased. The aortic band elongated upwards. Arch prominent, deeply shadowed. The descending aorta appears behind the heart as a dense curved band.

Case 3.—Male, 53 years old. Severe neurasthenic. Clinically there is accentuation of the second aortic sound only. The shadow of the aorta is elongated. All parts widened. Remarkably dense shadow of the aorta.

Case 4.—Female, 47 years old. Arteriosclerosis as a cause of death is shown in the family history. In early life nephritis after scarlet fever. For years, albumin in the urine. The functional kidney test shows an unfavorable result. Blood pressure: diastolic 120; systolic 230 mm. Hg. Systolic murmur, second aortic sound accentuated. Blood Wassermann negative. The X-ray film shows enlargement and elongation of all parts of the aorta.

Case 5.—Male, 57 years old; formerly confirmed drunkard. For several years, arteriosclerosis of the aorta besides nephritis. Functional kidney test very unfavorable; albumin and casts in the urine. Blood pressure: diastolic 120; systolic 230 mm. Hg. The aorta appears much dilated in all parts. The arch is marked as a dense shadow.

SYPHILITIC CHANGES OF THE AORTA

In syphilitic changes of the aorta we find at first, in the early stages, a gradually increasing widening of the shadow of the entire aorta. More rarely there is an elongation of the vessel. The shadow is not so dense as in the case of arteriosclerosis. The different parts are not as easily distinguished. The X-ray shadow of the thoracic aorta may in such cases be called "softer." The arch is less prominent; the margins are less clear and often wavelike.

CASE REPORTS

Case 6.—Male, 62 years old. Had syphilis 34 years before present examination, for which he was treated sixteen times. The aorta is moderately enlarged in all parts, but not elongated. The single parts are not at all differentiated, or only with great difficulty.

Case 7.—Male, 46 years old. No signs of syphilis. Systolic murmur. Blood pressure 130. The X-ray film is suggestive of syphilis. The Wassermann test was made and found positive.

Case 8.—Male, 76 years old. Recently had apoplexy. Blood pressure: diastolic 100; systolic 200 mm. Hg. Typical X-ray appearance of specific aortitis. Diffuse soft enlargement of the aortic shadow, of no great density.

ANEURYSM OF AORTA

Aneurysms of the aorta are nearly always the consequence of a syphilitic aorta. Saclike, non-syphilitic aneurysms may occur only after trauma. On the other hand, spindle-like aneurysms, either of sclerotic or syphilitic origin, are rarely ever to be distinguished from ordinary diffuse dilatations of the aorta.

CASE REPORTS

Case 9.—Male, 58 years old. Most serious attacks of aortalgia. Clinically there are scarcely any findings. Syphilis not confirmed. Wassermann test 3 plus. Following intravenous injections of Iodine the aortalgia disappears. Section reveals, besides the aneurysm, esophageal cancer.

Case 10.—Had syphilis 37 years before present examination. Wassermann test 2 plus. Clinically there are no special findings. The X-ray film shows aneurysm of the arteria anonyma.

ENDOCARDITIS AND SYPHILIS OF AORTIC VALVES

The differential diagnosis between endocarditis and syphilis of the aortic valves is easily made by the history of the case. The cardiac roentgenogram of both diseases is almost the same, but, in syphilitic cases, the shadow of the aorta shows the signs we find in syphilitic aortitis, especially the diffuse, soft, dilated shadow of the vessel. In endocarditis, or heart failure, on the other hand, it is generally only the shadow of the ascending aorta which is enlarged.

CASE REPORTS

Case 11.—Male, 50 years old. Heart disease for years; in spite of treatment his condition became worse. Clinically there were symptoms of insufficiency of the aortic valve. Wassermann test 3 plus. After an energetic anti-syphilitic treatment twice a year for the past two years, besides heart treatment, his condition has improved. Highly characteristic in the X-ray film is the soft shadow of the aorta.

Case 12.—Male, 59 years old. Has been operated on, without result, on account of gastric disturbance. Clinically the picture is of an insufficiency of the aortic valves. Wassermann test positive. After anti-syphilitic treatment the Wassermann test was negative. The X-ray film shows a remarkably soft, diffuse, dilated aortic shadow.

SYPHILITIC PROCESSES OF CORONARY ARTERIES

Syphilitic processes of the coronary arteries are rare, as is well known. Angina pectoris, often seen in luetic cases, is mostly of the nervous or spastic type. Many patients, while still very young and soon after infection, complain of such stenocardial distress. On the other hand, the aortic pains, the so-called aortalgias, are mostly situated between the shoulder blades and are easily distinguished from true angina pains. Angina pectoris of organic origin, due to changes at the point of origin of the coronary arteries, has, generally speaking, a very bad prognosis.

CASE REPORT

Case 13.—Male, 44 years old. Lately has had most serious attacks of angina pectoris. At times also attacks of asthma bronchiale. Syphilis, very severe, twenty-two years previous to present examination, for which he was intensively treated for a long time. Wassermann test at times negative. Systolic murmur, heart sounds feeble, blood pressure low. Exitus after a very severe attack of angina pectoris, lasting two days. In the X-ray film the soft aortic shadow is striking.

The most difficult diagnosis is that of syphilitic muscular insufficiency of the heart, especially if it is not combined with one of the above-mentioned diseases.

GUMMATOUS AFFECTIONS OF HEART MUSCLE

Gummatous affections of the heart muscle may lead to disturbances of the conduction system, especially heart block, but a diffuse interstitial myocarditis can be diagnosed only by the successful outcome of the treatment. We may find changes in the pericardium, and in most cases the lungs are also affected. This may be determined by the X-ray examination and especially when a right-sided hydrothorax is found.

CASE REPORT

Case 14.—Male, 66 years old. Syphilis forty-four years previous to present examination. Wassermann test negative. After a stay in a high altitude the heart troubles first occurred. Systolic murmur; perpetual arhythmia, a. s. o. *Diagnosis:* Myocardial

degeneration. In the X-ray film the wide aorta is the prominent feature.

SYPHILITIC AFFECTIONS OF LUNGS

In regard to syphilitic affections of the lungs in the tertiary stage of the disease, we knew almost nothing until a short time ago. Most such cases were incorrectly diagnosed as cardiac insufficiency. Many others were treated for tuberculosis. Only the roentgenogram reveals the frequent occurrence of pulmonary syphilis. We may distinguish the types presented by the following cases.

Thick nodular syphilis of the lungs shows in the roentgenogram as the characteristic circular and dense shadow of a gumma. There may be several gummata in the lungs or only a single nodule.

CASE REPORTS

Case 15.—Female, 45 years old. Continually suffering from shortness of breath and heart trouble. Diagnosis not yet established. The X-ray film shows, on the right side, near the hilus, three round shadows which are recognized as gummata. Wassermann test 3 plus. The miliary type of gummatous pulmonary syphilis may be mistaken for tuberculosis.

Case 16.—Female, 50 years old. On account of a cough, which had been treated without result, the patient was in a sanatorium for consumption. The husband was under treatment for syphilis of the aorta. Wassermann test for the woman was found to be 3 plus. The X-ray examination of the lungs showed miliary gummata. After anti-syphilitic treatment the cough disappeared and the lung fields cleared up entirely.

The interstitial-infiltrative pneumonic type, with exudation, is more frequent. Such cases may be taken for decompensated heart lesions or for cases of polyserositis. The characteristic signs are the right hydrothorax, the increased and distorted shadow of the hilus with linear extensions toward the periphery. Such cases may then be mistaken for tumors of the lungs.

Case 17.—Male, 47 years old, who had suffered for fifteen years from most severe, increasing dyspnea. Dilatation of the veins of the chest and body: clinically the symptoms of an aortic insufficiency: no syphilis: Wassermann test 3 plus. The X-ray examination showed large amount of exudate on right side; numerous rough spots at the hilum. Anti-syphilitic treatment gave immediate relief. For the past five years the patient has carried on his professional duties without difficulty.

Finally, the most frequent type is the cirrhotic interstitial type of pulmonary syphilis. These cases are clinically very often similar to cases of chronic bronchial asthma.

Case 18.—Male, 51 years old. Syphilis at the age of 22. No special complaints: some asthmatic troubles. The X-ray examination shows enlarged pulmonary fields, increased pulmonic markings, and nodular shadows in the hilus, such as are also present in cases of ordinary asthma.

Case 19.—Female, 45 years old, suffering from heart trouble. Clinically without special findings. The X-ray examination showed the same condition as noted above in Case 18. Under treatment, the asthma disappeared.

Case 20.—Female, 38 years old, came under medical care on account of severe asthmatic trouble. On the X-ray findings syphilis was suspected. The patient confirmed the suspicion, stating that she had had syphilis twelve years previously. Had had no children, but several miscarriages. Wassermann test negative. Anti-syphilitic treatment relieved her symptoms. Wassermann test for first time maintained negative, but in less than a year it was positive and improvement was continuous.

SYPHILITIC DISEASE OF ABDOMINAL ORGANS

Of syphilitic disease of the abdominal organs, it may be said that these especially are frequently overlooked.

We can distinguish two different types of syphilitic stomach affections: First, functional disturbances, especially pronounced in cases of locomotor ataxia. In such cases increased peristaltic waves, gastrospasm and other symptoms of irritation of the intestinal canal are to be noticed. Similar symptoms occur often in cases of cardiac syphilis. Then often the stomach trouble is the preponderant symptom, but only a heart examination reveals the cause.

Case 21.—Male, 61 years old, suffering from beginning tabes dorsalis. Severe gastric disturbance. X-ray examination showed an extremely hypertonic and hyperperistaltic stomach.

Case 22.—Patient, 59 years old. For half a year there had been pain when the stomach was empty. Loss in weight amounted to seven pounds. Clinically no special findings: Wassermann test 3 plus. The X-ray examination showed hyperperistalsis. Following anti-syphilitic treatment the symptoms disappeared.

Then, again, more rarely we find specific organic stomach changes, syphilitic gummata, ulcers, chronic changes in the mucous membrane, cirrhotic processes, etc., giving X-ray findings similar to those of gastric neoplasm or other organic stomach diseases.

Case 23.—Female, 33 years old. For two years there had been irregular gastric disturbance. Had had one miscarriage. Occasionally an examination of the stomach had been made and the heart had been radiated, in the course of which the shape of the aorta had been noticed. The Wassermann test being found to be 3 plus, the changes in the incisura angularis, which had been thought to be a sign of carcinoma, were recognized as syphilis of the stomach.

So far, I have not observed syphilitic disease of the small intestine and the colon. Some cases were similar to those of ulcerative enteritis, and in some I found strictures due to chronic enteritis or gummatous processes.

One might mention many interesting points regarding syphilitic diseases of the kidneys. For years I have had about a dozen patients under my supervision with well developed symptoms of chronic kidney disease, some with, some without, hypertention. In several of these the Wassermann test has been negative. Very often, after long unsuccessful treatment, we started anti-syphilitic treatment. The patient would improve by degrees, especially under intravenous injections of Iodine.

SYPHILITIC DISEASE OF THE LIVER

Still to be mentioned is syphilitic disease of the liver. Here, too, I have seen many cases in which the differential diagnosis could not be made with certainty for years. The patients were treated as heart cases, or cases of cirrhotic liver, without success. Then, even when the Wassermann test was negative, combined bismuth, mercury, and Iodine treatment succeeded.

LATE CONGENITAL SYPHILIS

Finally, there is late congenital syphilis (syphilis congenita tarda) of the viscera, of which, up until a few years ago I did not know of a single case. However, since I have begun to recognize them, I have seen them with relative frequency. In such cases the liver disease predominates; secondarily, we then find symptoms of insufficiency of the heart, and at the same time the characteristic symptoms of syphilitic changes on the aorta often are to be seen, and we may find symptoms of syphilitic disease of the kidneys.

Case 24.—Male, 48 years old. He was

treated for years for severe heart failure after articular rheumatism. There was continually present an enormous enlargement of the liver. Also continual decompensation. Heart remedies were employed, without result. The Wassermann test showed autoinhibition. The patient's history revealed that both his parents and six brothers and sisters had died of some syphilitic cerebral condition. After an anti-syphilitic treatment, improvement was immediate: the large right-sided exudate was reduced and the shadows of the lungs became clear.

Case 25.—Male, 51 years old. Mother and father had died of syphilis. One daughter had slightly positive Wassermann test. For some years there had been insufficiency of the heart, with very large liver and right-sided hydrothorax. After anti-syphilitic treatment and heart treatment besides, there was marked improvement.

Case 26.—Male, 45 years old, never had been sick, yet at the age of 23 the blood pressure had been 185 Hg. Always had slightly enlarged liver. Suddenly, after a stay in the mountains, there had been a breakdown, with enlarged liver and hydrothorax. For years the treatment was without result. Subsequently it was learned that his father died of paralysis.

CONCLUSIONS

The roentgenologic examination of the different types of syphilitic affections of the viscera very often gives characteristic and distinct signs. Even if the history of the case and the Wassermann test are negative, we are able to establish the diagnosis. But after all, the result of treatment alone can decide whether the diagnosis is right or wrong.

INTERPRETATION OF GASTRIC SYMPTOMS[1]

A CLINICAL AND ROENTGENOLOGICAL STUDY OF THREE THOUSAND CASES

By MAURICE F. DWYER, M.D., and JOHN M. BLACKFORD, M.D.,
SEATTLE, WASHINGTON

IT is a well known truth that the majority of patients consulting a physician on account of gastric symptoms do not have organic gastric disease. Four years ago we presented a statistical study of 1,650 patients complaining of chronic dyspepsia. We have continued this investigation and believe it may be of interest to roentgenologists as well as clinicians to present briefly the conclusions drawn from a routine examination of 3,000 consecutive patients, requiring a gastro-intestinal examination before a final diagnosis could be reached. Such an examination included the taking of the clinical history, physical examination, roentgen gastro-intestinal study, the usual routine laboratory tests, and other roentgen and laboratory examinations when indicated. The final diagnoses have been made only after careful correlation of all clinical, laboratory, and roentgen evidence.

Errors in diagnosis undoubtedly exist; yet we feel that the same percentage of errors in the various diagnoses are fairly constant, hence the figures are relatively correct. It is now very probable that after a careful routine examination less than 10 per cent of patients' major complaints are wrongly diagnosed.

In the study of 3,000 consecutive histories of patients having a gastro-intestinal examination, 450 (or 15 per cent) received a diagnosis of organic gastric lesions. These 450 diagnoses comprise 295 duodenal ulcers, 57 gastric ulcers, 92 gastric cancers, 2 cases of gastric syphilis, 3 cases of benign gastric tumors, and 1 gastric hair ball. Extra-gastric conditions are by far the chief causes of stomach trouble. In 85 per cent of the series the stomach was found not to be the primary cause of the dyspepsia.

Duodenal ulcer is the most frequent lesion of the stomach, or the duodenum causing gastric symptoms, and comprised 65.7 per cent of the organic gastro-duodenal lesions and 8.1 per cent of the number of patients complaining of gastric symptoms. In this series the average age of patients suffering with duodenal ulcer was forty-one years. Fifty-six per cent stated that the onset of their present gastric complaint began before the age of twenty-five, and 25 per cent before the age of twenty. The diagnosis of duodenal ulcer depends upon two salient factors: carefully obtained clinical history and proper interpretation of X-ray findings.

It is relatively rare for the roentgenologist to demonstrate an ulcer without at least a suggestive clinical history, and, conversely, the roentgen report, when returned to the clinician, seldom disappoints him if he has sufficient clinical evidence to cause him to suspect strongly the presence of an ulcer. When frequent differences affecting the final diagnosis arise between these two departments, they are generally due to an unbalanced ratio of proficiency or to a lack of confidence in one another's judgment.

A study of 100 consecutive clinical histories of duodenal ulcers showed that 82 per cent gave the so-styled "typical duodenal ulcer history," and 14 per cent a suggestive history, which may or may not have meant ulcer. The so-called typical history of duodenal ulcer is of great importance and we wish in no way to detract from its high value in the diagnosis of such a lesion, but if one depends solely on the history many ulcers will remain undiagnosed or confused

[1]Read before the Radiological Society of North America at the Fourteenth Annual Meeting, at Chicago, Dec. 3–7, 1928.

with other abdominal conditions, causing gastric symptoms, as 18 per cent of the cases studied gave anything but a classical history. In those cases with definite ulcer symptoms the roentgenologist is of great value in confirming the diagnosis. In the group presenting suggestive and indefinite histories, the roentgenological examination will determine or exclude more ulcers than the combination of all other diagnostic methods.

Gastric ulcer was diagnosed 57 times in this series and comprised 12.6 per cent of the organic gastroduodenal conditions—one-fifth as common as duodenal ulcer. The average age at the time diagnosis was made was forty-eight years. In comparing the histories of gastric and duodenal ulcer patients, it was interesting to note that only 36 per cent sought relief before forty-five years of age, 25 per cent before the age of twenty-five years, and only 3.5 per cent stated that their stomach bothered them before the age of twenty. Gastric ulcer, in comparison with duodenal ulcer, is essentially a disease of older persons. Seventy-five per cent dated the beginning of their trouble after the age of twenty-five.

The clinical differentiation between gastric and duodenal ulcer is frequently difficult, as many gastric ulcers are atypical and present an indefinite history. Here the roentgenologist localizes the lesion and occasionally is able to establish the presence of an ulcer when the clinical signs and symptoms are highly inconclusive.

The largest percentage of gastric ulcers occur along the lesser curvature, extending slightly onto the posterior wall. If these ulcerations are more than mucosal erosions, their direct presence will generally be recognized. It must be remembered, however, that approximately 16 per cent of gastric ulcers are located on the posterior wall, a considerable distance from the curvature, and unless the roentgenologist is constantly on his guard and employs as a routine the method advocated by Carman for examining the posterior gastric wall, many posterior ulcers may be overlooked.

Next to duodenal ulcer, cancer is the most frequent lesion of the stomach and duodenum. Ninety-two patients in this series suffered from cancer of the stomach. Twenty per cent of gastroduodenal conditions and 3.5 per cent of general gastric symptoms were found to be due to cancer of the stomach.

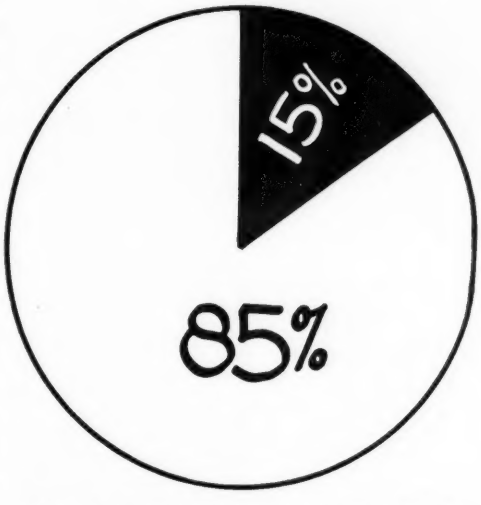

Chart 1. Gastric and duodenal lesions. Four hundred fifty (or 15 per cent) of 3,000 patients complaining of gastric symptoms had lesions in the stomach and duodenum.

A review of the histories of our cancer patients has brought out some well-known facts. Cancer apparently originated in 80 per cent of our patients in a resectable part of the stomach. Early pyloric obstruction was a fortunate complication, because it brought the patient in early for relief.

Eighty-three of these gastric cancer patients were studied as to duration of illness and amounts of gastric acidity. Thirty per cent had a previous possible, or probable, ulcer history. Seventy-five per cent of these ulcer-cancer patients had free hydrochloric acid present, some in excess of normal. The 70 per cent without a suggestive pre-

ulcer history presented only one case with free hydrochloric acid and in that instance the acids were below normal.

Practically all patients presenting short histories had developed marked evidence of the disease when consulting us. The history of early cancer of the stomach is very indefinite and the text-book symptoms of cancer should no longer concern us. The roentgen determination of the presence or absence of cancer so far surpasses all other known methods that such examination should never be undertaken without it.

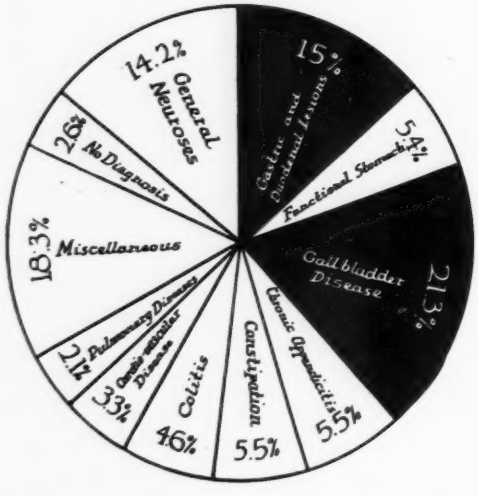

Chart. 2. Final clinical diagnoses of 3,000 patients with gastric symptoms.

The three cases of benign gastric tumors which were found taught us that one must continuously bear in mind that a benign gastric tumor, although rare, may be the cause of an atypical gastro-intestinal complaint or an unexplained chronic anemia. The first case was a leiomyoma; the second, five very vascular mucous polypi; the third, a large fibromyoma. In reviewing these three cases of benign tumors of the stomach, we were impressed by the absence of gastric symptoms. All the patients complained of weakness, anemia, and loss of weight, but none attributed his ill health to a lesion in the stomach. Diarrhea was present in two cases. In the patient having the polypi, diarrhea was practically the sole complaint. After removal of these polypi the diarrhea stopped and has remained so to date, eighteen months after the operation. All the tumors found in these three patients were located on the posterior wall of the stomach. One case in all probability would not have been diagnosed had we not made it a routine to carefully palpate the partially barium-filled stomach during fluoroscopy.

We believe that gall-bladder disease is the most common cause of stomach symptoms, and have carefully tabulated our findings relative to this statement for the past eight years. In 1924 we reviewed 1,650 consecutive histories of chronic dyspepsia, and gall-bladder disease was diagnosed in 19.3 per cent of the series. In 1926 the study was increased to 2,225 patients and the percentage of biliary tract disease was found to be 20.4 per cent. In reviewing 3,000 cases the gall bladder and ducts are considered responsible for the symptoms in 21.3 per cent. This percentage remains fairly constant throughout the entire series. The incidence of gall-bladder disease is one-third greater than of all the organic gastro-duodenal lesions together. Owing to the fact that gall-bladder disease is such a relatively common condition and that, for the past few years, so much investigation has been done regarding this organ, a review of some clinical aspects of the disease may be of interest.

Dowling, reviewing the gall-bladder diagnoses in our clinic up to January 1, 1928, noted that 1,004 patients out of a total registration of 26,500, received a diagnosis of disease involving the gall bladder or bile ducts. This is an incidence of 3.8 per cent. Only 8 per cent of the total registration was under the age of fifteen, so that, for practical purposes, this may be considered a group of adults. The history of gall-bladder disease is the most important single factor in

the diagnosis. This review showed that the early and prominent symptoms were dyspepsia in 64.5 per cent and pain in 35.5 per cent of cases.

An analysis of the term "dyspepsia," as applied to biliary tract diseases, showed that the most common complaints were gas, distention and belching, food selection, sour stomach and heartburn, bilious spells, acid eructations, headaches, and constipation. Vague abdominal and chest pains were frequently noted. Soda relief was not uncommon and abstinence from food generally gave relief.

All these symptoms may be found in dyspepsia from other causes, but their association in a group, accompanied in at least one-third of the cases by occasional severe radiating epigastric pain, in another third by less severe pain, by occasional jaundice and septic symptoms with frequently absent or low acids, and a negative roentgenologic report of the organic gastroduodenal conditions, makes the diagnosis correct in over 90 per cent of those checked by operation. To these add the positive aid of cholecystography and the diagnosis of gall-bladder disease becomes as accurate as of other gastrointestinal lesions. The operative findings have agreed with the pre-operative diagnoses in over 90 per cent of the cases.

A recent study of 200 consecutive case histories of patients receiving a diagnosis of gall-bladder disease to determine the degree of gastric acidity showed that 71 (or 35.5 per cent) had normal amount of acid; 82 (or 41 per cent) low acids, and 47 (or 23.5 per cent) absent acids. Thus, 64.5 per cent had low or absent acids. No record was found of any of these 200 patients who had high acids. Since this study was made we have record of one patient having high acids on whom a diagnosis of gall-bladder disease had been made. Low or absent acids in a patient with chronic gastric disturbances speaks strongly for gall-bladder disease, and the clinician should not be hasty in diagnosing disease of that organ in the presence of high acids.

Cholecystography has been used for the past two years practically as a routine method of examination in all cases suspected of having gall-bladder disease. We have studied over 600 patients by this method and are convinced that cholecystography far surpasses all previous objective means of examining the gall bladder. After trying both oral and intravenous methods of administering the dye, the intravenous is preferred, and has been used exclusively for the past year. Positive evidence of gall-bladder disease, such as absent or faint concentration of the dye, speaks more for impaired function and disease of that organ than any other method of objective examination. On the other hand, a well visualized gall bladder does not necessarily rule out disease of that organ, as a gall bladder may be diseased and still retain the power of concentration.

The clinicians have diagnosed gall-bladder disease in 12 per cent of the cases giving negative cholecystographic findings.

General neuroses and the various functional dyspepsias bring more patients to the physician than any other type of indigestion; no patients require more careful diagnosis. The neurotic, fat female of forty, with an indefinite dyspepsia as part of a long line of complaints, will cause a great deal of worry for the conscientious physician. Such women often have gallstones and these are found by cholecystographic methods, even when they are responsible for only a small portion, or for no portion, of the patient's complaint. Such patients do not get symptomatically well after cholecystectomy.

The thin, gassy, debilitated female of forty may show occasionally no cholecystographic shadow at a first examination, yet at a second examination we may find a normal gall-bladder shadow, or operation may show an apparently normal gall bladder. This fact has been noted by us and has been

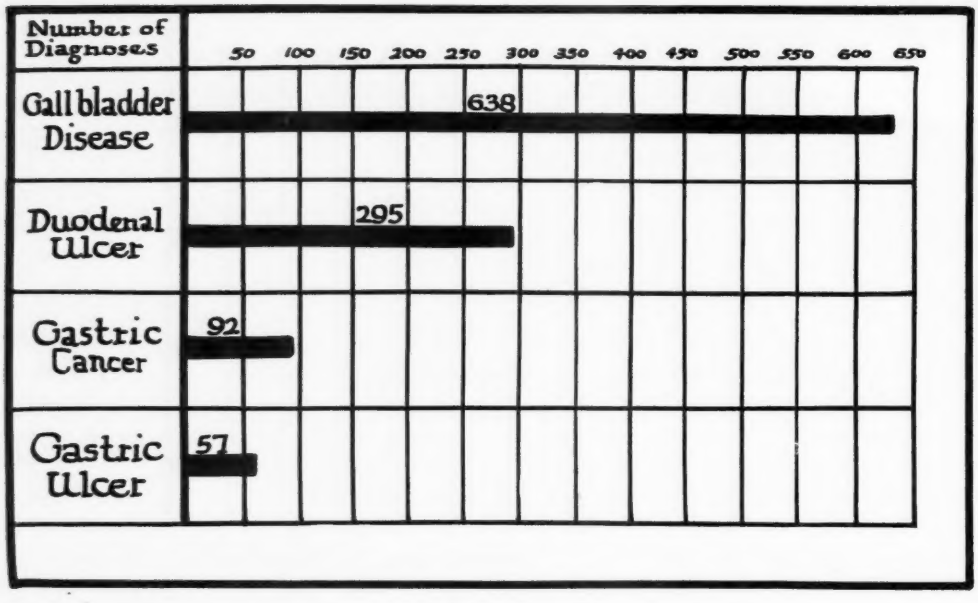

Chart 3. Frequency of clinical diagnoses of gall-bladder disease, gastric and duodenal lesions.

reported by Eusterman. Such failure to visualize the normal gall bladder must be due to some temporary functional failure of the normal gall bladder to concentrate the bile.

Functional disturbances have often been diagnosed as due to organic disease, and patients with gastric organic dyspepsia may have an overshadowing functional disturbance. For this reason we feel that close cooperation between the roentgenologist and the internist is essential to the attainment of a high percentage of finally accurate diagnoses.

The combined diagnoses in our clinic of all organic lesions of the stomach, duodenum, and gall bladder total only one-third the number of those that have had digestive symptoms sufficient to warrant a gastro-intestinal or cholecystographic examination. Two-thirds of all dyspeptics have had their stomach symptoms secondary to extra-gastro-cholecystic disease or to functional derangement.

SUMMARY

1. Fifteen per cent of patients complaining of chronic gastric disturbances have organic conditions in the stomach or duodenum, accounting for the symptoms.

2. Duodenal ulcer accounted for the symptoms of 8.1 per cent of the total series and was the most frequent organic finding in the stomach and duodenum. Fifty-six per cent of the patients stated that their gastric disturbance began before the age of twenty-five.

3. Gastric ulcer is one-fifth as common as duodenal ulcer and is comparatively a disease of older individuals. Seventy-five per cent began to have stomach symptoms after twenty-five years of age.

4. Twenty per cent of organic gastro-duodenal conditions and 3.6 per cent of general gastric symptoms were due to cancer of the stomach. Eighty per cent of these cancers apparently originated in a resectable part of the stomach. Early pyloric obstruc-

tion is a fortunate complication, because it brings the patient in early for relief.

5. Thirty per cent of the cases of gastric carcinoma which had a previous possible or probable ulcer history had free hydrochloric acid present, some in excess of normal. In the 70 per cent without a suggestive pre-ulcer history, only one case showed the presence of free acids.

6. Gall-bladder disease is the most frequent organic cause of gastric symptoms. We believe the gall bladder was responsible for the dyspepsia in 21.3 per cent of the total series. Positive cholecystographic findings by the intravenous administration of the dye speak volumes for disease of the gall bladder. Negative cholecystographic findings in the presence of a good clinical history of gall-bladder disease and a negative roentgen report of the stomach and duodenum should not prevent the clinician from diagnosing disease of the gall bladder.

7. In 59 per cent of all cases presenting gastric symptoms the cause for the dyspepsia was not due to functional or organic conditions in the stomach, duodenum, or gall bladder.

DISCUSSION

Dr. Hans A. Jarre (Detroit): Few of us have an opportunity to follow our cases to the operating room; therefore it is interesting for us to hear from the different essayists a correlation of symptoms—clinical, roentgenological, and surgical. It is all-important for us to understand the problems of the surgeon and the internist. I believe that the procedure evolved by the Mayo Clinic, to attempt correlation between clinical syndromes and roentgenological observations after the X-ray report has been written, is the only advisable method. If we study our cases with a prejudiced mind most of us are apt to give indefinite reports and mislead the clinician, or more especially the surgeon.

On the other hand, we should strive for improvement in our technic and advancement of our knowledge. Of course, all routine methods, especially examination in different postures, must always be practised, but we also must pay attention to more recent and new observations; I would mention especially studies started originally and advanced by several European workers on the mucosa of the gastro-intestinal tract.

I have approached one of the chemical companies, asking them to attempt development of a colloid which, after introduction into the gastro-intestinal tract, will produce an opaque precipitate on the wall, thus rendering unnecessary the completely non-transparent barium suspension, permitting chiefly a study of the contours. I believe that considerable progress might be made if we could replace the non-transparent barium meal by some medium, which, forming a thin precipitate on the mucosa dense enough to produce fluoroscopically and roentgenographically visible shadows, would itself remain fairly transparent. The chemical company admitted this possibility, but refused to start any experimentation towards this goal. Such attempts have since been made abroad, and a preparation has been developed which evidently works well in the colon but has not yet been found suitable for the stomach. I think these investigations will further the progress of gastro-intestinal diagnosis beyond what we accomplish now with the non-transparent barium meal.

Another thought frequently occupies my mind: Why does the duodenum not form malignancies as does the immediately adjacent stomach? Is it because of the chemical reaction to hepatic and pancreatic secretions, or some other condition of soil which prevents malignancy? There is here a good field for study on the genesis of malignancy.

Dr. Dwyer (closing): Regarding the relative value of the X-ray and the clinical

history in the diagnosis of duodenal ulcer, the roentgenologic diagnosis has been confirmed in 93 per cent of the proven cases in this series. Sixteen per cent of the clinical histories of patients known to have duodenal ulcer were not by any means the so-called "classical story." However, the clinician and roentgenologist, after weighing all evidence, seldom disagree in the final diagnosis. When frequent final disagreements occur between these two departments it usually signifies that one is more versed in gastro-intestinal diagnosis than the other.

In regard to colitis, we have been very careful in making such a diagnosis and limit it for the most part to those cases presenting definite clinical or roentgenologic evidence, such as chronic ulcerative colitis and amebic colitis. Amebic colitis is a relatively common finding in the Northwest; there are over one hundred cases in this series. I am not prepared to say whether the apparent increase in this condition is due to dissemination of the ameba by Japanese or whether we now examine more stools.

RADIUM TREATMENT IN SKIN CANCER AND BORDERLINE MALIGNANCIES[1]

By ALDEN WILLIAMS, M.D., F.A.C.P., Grand Rapids, Michigan

IN recent medical literature we find numerous articles on the combination treatment of superficial malignancies—we also find reports on the radium treatment of small collections of cases but very few reports of sizable groups treated by radium alone.

The etiology of cancer is taking its eliminative course. Regarding the cause of skin cancer it would be unwarranted to accept any of the older suggestions, as irritation or infection, or even the newer conception of "local ergusia imbalance." And, on the other hand, it might be considered archaic to dwell on the microscopical romance of bolshevik cell activity.

For practical purposes we may accept the statement that cancer of the skin seems most often to be caused by chronic injury in a group of cells which, by virtue of their being unstable, react by unlimited proliferation. The basal cell malignancy is described clinically as scaly, elevated, edged, or ulcerated. The wax-like border, when seen, is most typical. Sometimes the biopsy is confusing to the clinician in that a report may come back: "mixed type of basal and squamous," or puzzling to the pathologist himself, who reports: "hyperplasia to the borderline of malignancy."

The clinical features, appearance, and history are usually sufficient for a rational basis of attack. The rodent ulcer type of this basal-celled epithelioma is a most satisfactory kind of malignancy to treat, because of its slow course and its infrequent involvement of lymph nodes. Its common occurrence about the nose and eyes makes it important that the treatment shall produce the best possible cosmetic results. Radium treatment is easy, almost painless, and, used conservatively, produces the least possible scar. The success of this type has probably been the cause of our own emphasis on radium treatment in preference to other exclusive methods or mixed methods.

The squamous lesion has a rougher surface, which speedily ulcerates, often indurates, sometimes spreads rapidly, and metastasizes early. Of course, all lesions are changed in appearance by irritation, infection, and previous treatment. Simple granulation tissue is usually redder, because of less cell-packing and greater blood supply.

Fig. 1-*A*. Patient aged sixty-four, treated April 18, 1927. Shows the simple basal type. Patient had flat mole-like lesion for three years: recently it began to grow. Radium was inserted in dose of 25 mg.-hrs.

Fig. 1-*B*. Taken June 10, 1927, showing the lesion completely healed. Time of healing, seven weeks. Reported well in September, 1929.

This report is based on a group of 540 cases which we have treated since 1920, and proves that the percentage of cures is fair enough to warrant our continued use of radium. Around the eyes and nose, where surgery is difficult, we have had our best results. Our experience has emphasized that irradiation treatment must be adequate but

[1]Read before the Radiological Society of North America, at the Fourteenth Annual Meeting, at Chicago, Dec. 3–7, 1928.

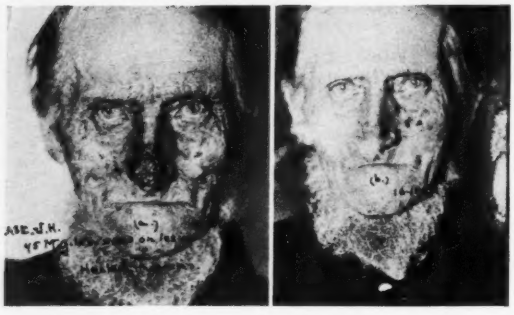

Fig. 2-*A*. Patient aged seventy-three, treated August 27, 1925. Keratotic epithelioma of nose. Duration, two years.

Fig. 2-*B*. Taken October 10, 1925, showing the lesion healed after six weeks. Forty-five mgs. of radium was applied to the surface with 0.3 mm. platinum filtration for one hour. Reported well four years later.

not overdosed, and if a lesion does not respond in the expected time, it is entirely expedient to apply another dose.

The use of radium in the treatment of malignancy is, of course, still in the try-out stage. However, we are noticing that less often do we ask ourselves *whether* it shall be used or not, and more often, *how* it shall be used. How much radium? At what distance? How much filtration? How often? Especially, whether it shall be used alone, or in conjunction with other curative measures. We think radium the proper treatment for superficial and borderline malignancies, especially in places where scarring must be avoided, and where all possible anatomical structures must be saved. Other recommendations are its theoretical accuracy and thoroughness in covering the local field. Some patients, due to their fear of surgery or refusal of operation, are to be considered as radiation cases *only*.

There has been much improvement in the irradiation method of handling epithelioma since 1908, when Pusey first advised small fractional doses of X-ray, often repeated. These first cases, we feel, were over-treated in the total dosage, and had insufficient basement membrane rest between treatments, to allow Nature to come forward with her healing process. In late cases, when the patient "has been the rounds," no method will give brilliant results. In some of these cases it has proved a nice problem to figure out in advance a fair prognosis. Some of our cases that looked hopeless are

Fig. 4-*A*. Patient aged eighty-three, referred August 4, 1926, by Dr. J. J. Rooks. Productive lesion on right side of nose, $2 \times 3 \times 1$ cm. in extent. Duration, two years.

Fig. 4-*B*. Taken September 27, 1926, showing the lesion almost healed seven weeks later, after use of 90 mg.-hrs. of inserted radium used in one dose. Reported still well in November, 1928.

Comment: "Inserted radium," in this report means the introduction of *radium element needles* into the lesion.

Fig. 3-*A*. Patient aged forty-five, treated July 30, 1924. Lesion of ulcerating type, 1 by 1½ cm., which followed freezing in 1909. Duration, fifteen years.

Fig. 3-*B*. Taken September 18, 1924, showing a lesion directly over cartilage which healed after a surface application of radium of 45 mg.-hrs. It recurred in the edge of the scar four years later and again healed after 45 mg.-hrs. surface radium application.

Comment: "Surface application," in this report means radium element needles on adhesive plaster applied directly to the surface of the lesion.

apparently cured, and a few cases that appeared somewhat promising proved to be failures. Irradiation technic is varied in different localities of the country, and has been changing as the years have passed.

Regarding the mechanism of radium action on cancer cells: There is a group that believes the theory of action to be more than a direct blanket dose, exterminating all neoplastic cells. They are convinced that there is a specific effect on the tumor mass, or on the ulcerating edge, with also some indirect, more subtile action in the immediate surrounding tissues. Sections taken through treated tissue at intervals show hyperchromatism of nuclei and hydropic swelling of tumor cells, with, later, cell atrophy. Still later, lymphocytes and plasma cells appear in the adjacent tissue structure, capillaries proliferate, and all these invade and replace the tumor mass, resulting in a slow regressive process, with exudation and proliferation of normal tissues, and the resulting cure.

Fig. 5-*A*. Patient aged thirty-three, treated January 3, 1925. Irregular mixed productive lesion under left eye. One year before he had had paste removal, with return in the edge of the scar. The inner canthus showed beginning ulceration.

Fig. 5-*B*. Taken April 18, 1925, showing the lesion entirely healed. Technic of treatment: 45 mg.-hrs. radium applied January 3, 1925: again on February 28, 1925. Lesion well in March, 1925, and reported still so on October 17, 1929.

In considering treatment and results, we make no claims to accurate microscopical cell classification. Rather, we seem to have joined the clinical group that gets along without biopsy, and feels that the average lesion can be diagnosed, in the gross, accurately enough for rational treatment.

Fig. 6-*A*. Patient aged sixty-five, referred August 2, 1923, by Dr. Dell. Epithelioma of left upper eyelid, $1 \times 1 \times 1\frac{1}{2}$ cm. in size. Duration of lesion, one and one-half years.

Fig. 6-*B*. Taken April 4, 1925, showing the lesion entirely healed. Technic of treatment: 75 mg.-hrs. inserted radium. Time of healing, six weeks. Reported well three years later.

In borderline cases we try to give the patient the benefit of the doubt, and manage such as malignancy cases. Our radium

Fig. 7-*A*. Patient aged eighty-three, referred September 4, 1923. Extensive ulcerating epithelioma of both upper and lower lids of left eye, with extension to median line of bridge of nose. Duration, five years. This patient had appealed to several clinics and had been discouraged regarding possibilities of operation or any other treatment.

Fig. 7-*B*. Shows same case five months later after improvement under radium. Technic: 220 mg.-hrs. of inserted radium used as initial dose around the edge of lesion. Then at intervals of six weeks, for five months it received a total of 240 mg.-hrs. of surface radium. Remained apparently well for three years and then recurrence appeared in inner canthus. Patient was quite feeble and received only partial treatment. Recurrence was not healed. Patient died of intercurrent illness.

Fig. 8-*A*. Patient aged seventy years, referred June 17, 1924, by Dr. Lewis Frank Ladd. Ulcerating epithelioma of right ear, 2 × 2 cm. in size. Duration, two years.

Fig. 8-*B*. Taken June 17, 1926, showing a lesion that entirely healed in six weeks after a radium surface dose of 70 mg.-hrs. Reported well two years later.

methods of treatment are the same in basal as in squamous. About 10 per cent of basal cell tumors contain squamous cells.

If radium is used, its limitations should be borne in mind. Its *possibilities* depend often on the judgment used in dosage, distance, screening, and follow-up treatment. No irritating antiseptic dressing should be used. Radium therapy should *not* be continued indefinitely. If not effective, it should be supported by X-ray, electric coagulation, or surgery. Usually one dose of moderately filtered radium of 60 mg.-hrs. per sq. cm. for thin, small lesions, then observation in from one to five weeks; after that a second dose, if necessary—and the clinical cure obtains. One dose of inserted radium for thicker lesions, approximately 84 mg.-hrs. per cu. cm. Then, repeating with a smaller dose to the surface, or occasionally inserted radium, six weeks later, if necessary. Remember that no chemical applications are to be used while the healing process is taking place.

In this healing process we expect a radium reaction in from five to fourteen days:

Fig. 10-*A*. Patient aged sixty-seven, referred March 29, 1922, by Dr. Rowland F. Webb. Ulcerating lesion 3 × 4 cm. in front of left ear. The upper part of lesion showed raised border, while the lower edge was flat and undermined. Duration of lesion, twenty-five years.

Fig. 10-*B*. Illustrates, in the rodent ulcer type, the healing result of three monthly applications of radium, totalling 240 mg.-hrs. Apparently healed in ten weeks. Recurred four years later, but received no further treatment. Patient died in 1927 of pneumonia.

Fig. 9-*A*. Patient aged eighty-nine, referred September 4, 1923, by Dr. C. O. Cilley. Large ulcerated epithelioma on right ear 2 × 3 cm. in size. Duration, three years.

Fig. 9-*B*. Taken June 4, 1926, showing lesion healed. Time required, eight weeks. Reported well five years after treatment (July 7, 1928).

erythema, or exudation, continues for approximately one week, then becomes less. The final scab comes off in from five to seven weeks, leaving a clean, shining base. The color and sensitiveness gradually disappear as the months go by.

Not even in the field of conjecture can we explain the healing tissue change on the basis of the data now available. Radiant energy is vitally related to the physiology of living matter.

Superficial and borderline malignancies belong to a type of pathology which has

been so long known that ideas of incidence, location, and appearance have been stabilized. Concerning treatment of superficial malignancies, however, we admit that, so long as no method has achieved a 100 per cent success, there will be new procedures tried. As soon as workers find something they think better than the previous lines of treatment, there comes the urge and the duty to report.

The surgical statistics of cures of fifteen years ago seem to range around an average of 68 per cent. This was good, and demanded that new methods be viewed conservatively. About ten years ago the new fractional X-ray method, claiming 90 per cent, was accepted with reservations. Waiting for recurrence, sifting of biased statistics, and avoidance of selection of favorable cases proved 90 per cent too high. About five years ago the combination of surgery and X-ray, with mass dosage, definitely pulled up the percentage of cures. Now we feel that men doing this work with superficial malignancies are sure that the addition of electric coagulation—and especially radium—has brought the cures up to a real 90 per cent. We feel that superficial cancer can practically always be cured with radium if seen while still a localized disease.

In observing cases of skin cancer treated with radium, one is especially impressed with the rapidity with which the average lesion responds. One gets the idea that radium is usually successful. To modify or justify this idea, our own 540 cases since 1920 were grouped and studied.

In following up the results of radium treatment, we may be quite sure of seeing the patient while the lesion is reacting—he is worried, and thinks himself worse: but it is hard to get him to come back for observation after the lesion is apparently cured. We find, however, that on request almost any patient will mail a stamped return letter of inquiry so planned as to require only a word or two of response.

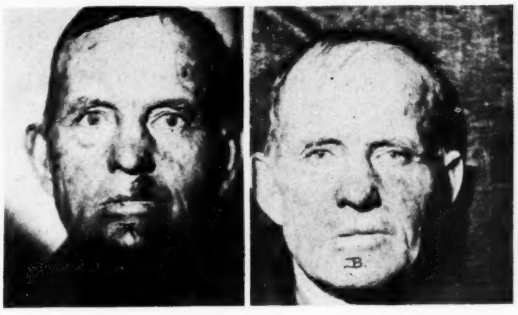

Fig. 11-*A*. Patient aged sixty-six, referred August 30, 1921, by Dr. Malcolm Smith. Epithelioma started three years previously on pigmented mole above upper lip. Mucocutaneous border not involved.

Fig. 11-*B*. Taken October 22, 1921, showing the lesion entirely healed. Technic: one application of 75 mg.-hrs. surface radium in the usual platinum needles. Well seven years later.

We have used the usual anatomical location grouping, with incidence and percentage of cure: also age and sex data. Patients surviving over two years and dying of intercurrent disease were not reported in the group as dying of cancer. The inconclusive cases, due to failure to return full data, and those at the present time untraceable, were left out of the group.

In reviewing our group of 540 cases, we find 28 recurrences (5 per cent), some of which were removed by additional radiation. In a previous small group of 25 cases,

Fig. 12-*A*. Patient aged seventy-two, referred May 5, 1927, by Dr. John Wenger. Epithelioma on neck back of right ear 1 × 2 × 1 cm. in size. Duration, three years. Shows the needle method of inserting radium. Dose 162 mg.-hrs.

Fig. 12-*B*. Shows the lesion entirely healed nine weeks later. Reported well two years later.

in 1919, when we treated by X-ray, there were 6 recurrences (24 per cent), which caused us to use less X-ray and more radium.

One must have faith and patience after the first dose of radium to wait for a maximum result. A remaining nodule is not always a remaining cancer. A new hard area may be a fibrosis, or healing hyperplasia, and may not need additional dosage.

Practically all reports seem to agree regarding the need of surgical or diathermic help near cartilage. We find a difference of opinion regarding the curability of hand and scalp lesions, and the indication for the use of radium. We have had equally good results in our small number of cases of these types. In our group of 51 eye cases, with radium placed many times less than 1 cm. from the cornea, we have had one corneal ulcer. That experience, however, made us decide to use metal eye protection in all lid work. In our lip group, the degree of success attained in the treatment by radium and the cheerful follow-up reports to date, justify a continuation of this method.

In considering the rather high percentage of clinical cures in our work, I have tried to re-examine our data, to hunt for errors and exceptions that may explain the added percentage of cures as compared with other reports. It is possible that my patients have come earlier than have those of other workers. The average duration of a lesion before application for treatment was one and a half years, though records on the duration of a lesion are probably not very accurate. The patient usually recalls that some defect has been present for years, then notices increase in size or change in character. In regard to the size, 27 per cent were under 1 cm. in extent. The sex and age incidence

Fig. 13-*A*. Patient aged seventy-nine, referred October 7, 1921, by Dr. J. D. Brooks. Shows a case of combination surgery and radium management. Original tumor removed by Dr. Henry J. Vanden Berg. Pathological report: squamous-cell epithelioma. Two months later recurrence developed at outer corner of eye.

Fig. 13-*B*. Shows recurrence 1 × 1 cm. in size. Ninety mg.-hrs. radium was inserted and lesion remained healed for five years.

Fig. 13-*C*. Taken September 3, 1927, showing another recurrence which also was removed by radium application. Patient died in September, 1928, of pneumonia.

agreed closely with other group reports. The average time for clinical cure was nine weeks.

Our failures were tragedies similar to those experienced by other workers. They were found in advanced cases, or in cases of gland involvement, or in cases previously given a round of treatments by paste, surgery, or cautery. They were sad indeed!

The lapse of time will improve upon all methods. The ease and simplicity of undergoing radium treatment will encourage earlier attention to the disease by the patient

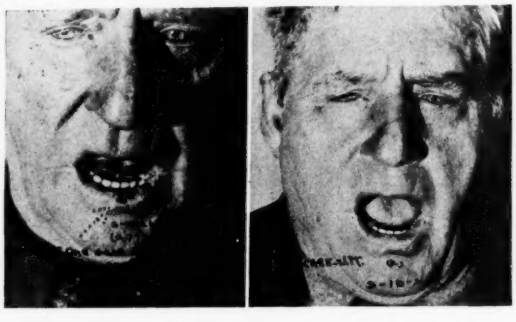

Fig. 14-*A*. Patient aged seventy years. This photograph, taken February 10, 1926, shows an indurated lesion 1 × 1 cm. in size on lower lip. Patient states that this was first a small scab, then became cracked and larger. Duration, two years.

Fig. 14-*B*. Taken March 16, 1926, showing lesion entirely healed. Treatment: 45 mg.-hrs. of surface application of radium. Healing required five weeks. Return letter, two years later, reported patient well.

himself. The cases of scabbing keratoses come to us unselected, and constitute a goodly percentage of the smaller lesions. We do not accept for treatment the frankly hopeless cases.

A satisfactory grouping of lesions in relation to character was found impossible on account of many overlapping decisions. A rough idea of the grade of our clinical material may be derived from the following arbitrary count: flat lesions, 152; ulcerating lesions, 148; productive lesions, 145; mixed and infiltrating lesions, 95.

Regarding the age groups, there were 2 patients under 19 years; 34 between the

Fig. 15-*A*. Patient aged forty-one. This photograph, taken April 29, 1925, shows epithelioma of lower lip 1½ × 1½ cm. in size. Duration of lesion, one year.

Fig. 15-*B*. Taken June 14, 1925, showing lesion entirely healed by 40 mg.-hrs. of surface radium application. Time required for healing was six weeks. Reported by follow-up letter to be well four years later.

ages of 20 and 39 years; 238 between the ages of 40 and 59, and 269 patients were over 60 years.

In the sex groups, 65 per cent of the patients were males.

In 265 cases at least four years have elapsed since treatment, and in 275 cases the time elapsed is from one and one-half to four years.

As radium is a new treatment, it is impossible to report a large series of cases observed over a considerable period of time.

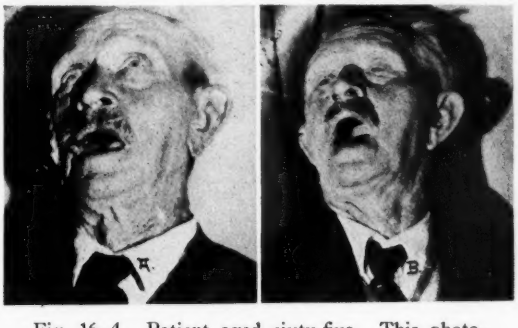

Fig. 16-*A*. Patient aged sixty-five. This photograph, taken November 12, 1926, shows ulcerating indurated epithelioma on right upper lip. Lesion has been growing slowly for two years.

Fig. 16-*B*. Taken February 5, 1927, showing lesion entirely healed by two surface applications of radium: November 12, 1926, 90 mg.-hrs., and January 8, 1927, 25 mg.-hrs. Still well, March 25, 1929.

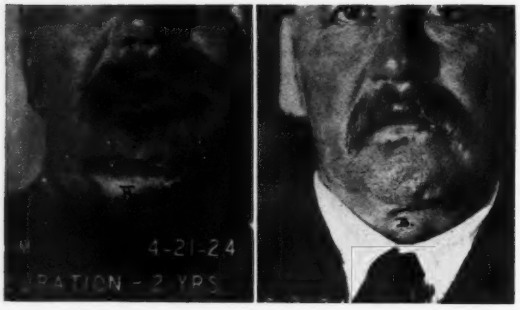

Fig. 17-*A*. Patient aged forty-eight, referred April 21, 1924, by Dr. Earl Cilley. Shows extensive indurated epithelioma of lower lip 3 × 1½ × 1½ cm. in extent. Duration, two years. Previous treatment: salves, caustics, etc. This illustrates the possibilities of saving deformity by radium management. Any coagulation or surgical treatment would have required complete resection of lower lip.

Fig. 17-*B*. Taken September 3, 1924, showing complete healing following inserted radium dose of 130 mg.-hrs. Four years later reported to be well.

MacKee reports 258 cases of superficial malignancy, with a cure percentage of 90. Johns Hopkins surgical clinic reports 83 per cent of cures in a surgical group. Time does not allow the comparison of single methods or the complicated, impossible appraisal of combined methods. In our own group there were 540 cases treated by radium alone, with a clinical cure percentage of 93 19/27 (Fig. 20).

Fig. 18-*A*. Patient aged thirty-five, referred February 12, 1924. Patient states that two months before examination the sore began growing after a scratch on the base of the middle finger. It may have been an infected granuloma, but was treated the same as an epithelioma.

Fig. 18-*B*. Taken April 3, 1924, showing the lesion entirely healed after dose of 75 mg.-hrs. of surface radium. Reported well four years later.

It has not been our practice to accept for treatment and grouping any symptomless, changeless moles or warts. We may be wrong in this, for it is known that there are records of metastasis with no evidence of change in the original mole, and also that if pre-cancerous lesions are treated successfully, there will be no cancer of the skin.

It is only ten years since the dogma of the surgical "V"-shaped excision was braved by a report of six lip cases treated by radium alone at the Memorial Hospital of New York. The medical profession's

Fig. 19-*A*. Patient aged eighty-one years, referred December 15, 1925, by Dr. P. J. Kriekard. Epithelioma on hand had been growing for six months, 2 × 2 × ¾ cm. in extent. Amputation at the wrist had been advised.

Fig. 19-*B*. Taken January 26, 1926, showing retrogression and healing at base. Reported well two years later.

brief experience with radium therapy should make us conservative. We need further radium statistics on larger, better classified groups, but until these are available many of us should add our bit toward arriving at a better standard of treatment.

SUMMARY

1. The limitations of radium therapy become less as one's experience increases in the treatment of superficial malignancies.

2. Although it is best for one to judge the radium dose required to accomplish a cure in one treatment, it is not imperative to do so, as stated by some workers. Neo-

plastic residue has many times responded to the second and third doses.

3. Our cures of lesions in proximity to cartilage have given us reason to hope in radium alone for many of these cases.

4. With superficial lesions, we have had our most reliable results with moderate filtration.

Superficial Malignances and Radium Therapy.

Location	Cases Treated	No. not Cured	% not Cured	No. Cured	% Cured
Nose	106	5	4 38/53	101	95. 15/53
Eyes	51	4	7 43/51	47	92 8/51
Ears	31	3	9 21/31	28	90. 10/31
Face	178	7	3 83/89	171	96. 6/89
Lips	95	8	8 8/19	87	91. 11/19
Extremities	43	3	6 42/43	40	93 1/43
Body	45	4	8 8/9	41	91 1/9
Total Cases	540	34	6 8/27	506	93 19/27

Fig. 20

Fig. 21-*A*. Patient, aged forty-three, referred August 8, 1924, by Dr. Glenn Easton. An ulcerating epithelioma on lupus base under right eye. Duration of lupus, fifteen years; of ulceration, one year.

Fig. 21-*B*. Photograph made Sept. 5, 1925. One dose of 60 mg. of radium inserted in edge, followed by four doses at intervals of six weeks of 60 mg.-hrs. of surface treatment. *Comment:* Several moderate X-ray treatments and many ultra-violet light treatments were also given this case during 1924. Completely healed. Reported as still well November 15, 1928. Not included in group statistics.

Fig. 22-*A*. Patient aged fifty years. Shows a developing epithelioma on right cheek in an old lupus base. Duration of lupus, fourteen years; of epithelioma, three months.

Fig. 22-*B*. Shows lesion entirely healed after application of 60 mg.-hrs. of surface radium. Healed in five weeks. Lesion still well five years later. Lupus required ultra-violet and X-ray management.

5. We have learned to plan on greater spacing of time between treatments, and no antiseptic dressings in the average epithelioma.

6. The recurrences are fewer in our radium-treated group than in our previous X-ray group.

7. Although the required average radium dose figured less in the latter part of our series, we feel convinced that the best explanation for marginal recurrence is insufficient dosage.

8. Results as traced by follow-up correspondence and observation were 93 per cent successful.

We are hoping that discussion and deduction may arise from this report that will lessen the percentage of failures and increase the percentage of cures in superficial malignancies.

THE USE OF SMALL AMOUNTS OF RADIUM AT A DISTANCE IN THE TREATMENT OF CARCINOMA OF THE MOUTH AND FACE[1]

By R. T. PETTIT, M.D., Ottawa, Illinois

THAT radiation—the use of X-rays and Gamma rays of radium—is useful in destroying cancer cells has been an established fact for a number of years. X-rays of even long wave length—in what to-day would be considered very small doses—were shown to be effective in decreasing the size of the spleen in splenomyelogenous leukemia by W. A. Pusey, in 1896, and at almost as early a date epitheliomata of the skin were successfully treated by both the Gamma and Beta rays of radium. The results were by no means uniformly successful but even at that early date it was clearly shown that, potentially at least, radiation was an effective agent in the treatment of malignancy.

With the gradual accumulation of knowledge both as the result of careful clinical observations, with statistical studies, and painstaking laboratory investigations both of biopsy material and spontaneous and implanted carcinomatous growths in animals, the hit-or-miss methods and inconsistent results of that early day have been replaced, until to-day increasingly successful results are being achieved. The possibilities of the method, however, have been by no means exhausted, and with increasing knowledge and the application of this knowledge to the treatment of malignancy in the human we may reasonably expect increasingly successful results.

It is the purpose of this paper to review some of the advances made in our knowledge of the action of radiant energy upon the aberrant malignant cell and perhaps to point the way to the application of this knowledge to clinical malignant disease, with particular reference to malignancy in the mouth.

The real problem confronting us, it seems to me, is the determination of, and the better understanding of, what constitutes radiosensitiveness and radioresistance. Is the action of radiation a selective action on the malignant cell, and, if so, why are some malignant cells extremely sensitive to the action of radiant energy and others extremely resistant?

No clearly convincing proof has been presented, to my mind at least, that the action of the radiation—be it roentgen ray, or Beta or Gamma ray of radium—is a selective one on malignant cells. Radiation, it is true, will destroy malignant tissue in many instances, leaving the normal tissues intact, thus giving the impression of a selective action, but if a sufficient dose is used, it can be shown at any time that benign growths and normal tissues can be destroyed equally as well.

There has also been—during the past few years more so than at present—a great deal of discussion of the "stimulating" and "destructive" action of radiation. This controversy, I believe, has finally been laid at rest and the consensus of opinion to-day is certainly that of considering the action of radiation solely as a destructive one, in the same manner as a strong corrosive chemical or a physical agent such as heat. Radiation does not stimulate growth; it destroys life; its action on living cells, plant or animal, benign or malignant, is to injure them. The more easily they are injured, the more easily are they killed. There is nothing specific or at all selective about the action of radiant energy. Most cancer cells are more easily killed than most normal

[1]Read before the Radiological Society of North America at the Fourteenth Annual Meeting, at Chicago, Dec. 3–7, 1928.

cells, it is true, but the action is merely one of *degree* rather than of *kind*.

We are all aware of the great variations in reaction in both normal and malignant tissues. We are familiar with the action of radiation upon the highly susceptible lymphocyte and the resistant cells of the cornea, the brain, and even muscle, and almost daily we are presented with striking examples of the variations in susceptibility of different types of cancer. What is the factor or factors that determine radiosensitivity and radioresistance? If this question could be answered fully and satisfactorily, it would mark a distinct advance in our knowledge of radiotherapy. Much has been done in this field, particularly in morphology, and beginnings are being made in cellular physiology—both normal and pathological—and much may be expected of the future; but if our present knowledge, imperfect though it may be, were practically applied and utilized to its fullest extent, or even to a fuller extent, by those engaged in radiotherapeutics, I feel warranted in saying that results would improve.

I refer particularly to our knowledge of cellular morphology, pathology, and physiology.

An important milestone on this road is the law of Bergonie and Tribondeau, stated by Colwell and Russ in their book on "Radium, X-ray, and the Living Cell," (1) as follows: "Immature cells and cells in an active state of division are more sensitive to X-ray than are cells which have already acquired their fixed morphological and physiological characteristics."

In other words, if we but recognize this important fact, *resistance* and *susceptibility* to the destructive action of X-rays and radium are questions of the *rate of cell growth.*

Let me refer you to the work and publications of Ewing. His papers on cellular pathology in relation to radiation should be studied, not simply read. This knowledge which Ewing has so painstakingly dug out in his laboratory is capable of practical application. This has been clearly and conclusively shown during the past few years by the careful statistical studies of Broders (2) and Henry Schmitz (3) on biopsy and surgical material. Under the microscope they have shown that cases can be classified and prognoses made that are completely confirmed by the clinical statistics and results. This on the appearance of the cells under the microscope. Their studies, again, clearly show the close relationship between cellular susceptibility to destructive agents (surgical or radiological) and the rate of cell growth.

The rate of growth, I am sure it is clear to all, is not determined by an increase in the size of the individual units or cells, but by an increase in number of units or cells. The rate of growth is determined, then, by the rate of cell division. The study of cell division thus becomes one of the most important factors in this field. It is the all-important factor in determining the susceptibility and resistance of the tissue or growth to destructive agents and determines the curability and prognosis in the individual case, because, during the stage of division, cells, both normal and malignant, are much more susceptible to destructive agents, particularly radiation, than at any other time.

Schinz (4) says: "The cell divides, but while it is undergoing division it seems to be in an enfeebled condition. A dose of roentgen rays strong enough to necrotize the highly sensitive cells of lymphoid organs leaves unimpaired the less sensitive cells of a spindle-cell sarcoma or basal membrane carcinoma, excepting if it happens to strike them in the act of mitosis. In that event the cells succumb."

Colwell and Russ (1) report experiments by Mottram in which he exposed the ova of *Ascaris* in various stages of nuclear division to the Beta and Gamma rays from seven

milligrams of radium and found them to be *eight times* more vulnerable in active division than they were in a resting condition. They further state: "There is no doubt but that the same intensity of rays does produce very similar effects upon cells of different varieties. From the lowest forms of vegetable and animal life to complex animal tissue this is true." We may, therefore, I believe, accept these experimental results and apply the knowledge thus gained to human cancer problems.

To recapitulate: Radiation is a non-specific, destructive agent.

The rate of cell growth determines, in a large measure at least, the degree of susceptibility.

Cells are much more sensitive to radiation during mitosis than during their resting stage.

The practical application of this knowledge is extremely important. If the cancer cells can be subjected to the action of radium and X-rays during their period of cell division, they can be destroyed with much smaller doses, doses that will cause a minimum amount of damage to normal surrounding tissues. Unfortunately, all the cells do not undergo mitosis at the same time, but this process is going on continuously. In order to catch *all* the cancer cells (and unless all are caught the treatment is obviously ineffective), the period of time elapsing to cover the life cycle of a single cell should be known in each instance.

Unfortunately, again, this is not known and probably varies greatly under different conditions.

The life cycle of a cell in the cortex in the brain is undoubtedly much different from that of a lymphocyte, and there are undoubtedly as great or greater variations in cancers of different points of origin and in different individuals. Be that as it may, I have convinced myself, and I am sure my experience is not peculiar, that a massive dose of radiation (either radium or X-ray) for a short period of time is not so effective as a smaller dose over a prolonged period of time. In deep X-ray therapy the massive dose of five or six years past has been almost entirely replaced by the fractional dose method.

In the use of radium this is not so, particularly in many clinics in this country. Most of the large institutions that I have visited seem to feel that large quantities of radium are not only desirable but necessary for its successful application in the treatment of malignancy. This is not the generally accepted opinion, however, in some of the European institutions, especially in the French and Belgian ones, in the application of radium in cases of cancer of the mouth. The Radium Institute at Brussels, under the supervision of Dr. Sluys, has, through the courtesy of the Radium Company of Belgium, an almost unlimited quantity of radium at hand. In spite of the fact that they have at their disposal some seven or eight grams of radium, in the treatment of many cases—particularly in cases of cancer of the mouth—better results have been achieved with the use of very small quantities of radium for prolonged periods of time. Instead of using several grams of radium for a number of hours, capsules of radium containing ten or twenty milligrams with extremely high filtration (2 mm. of platinum), placed four centimeters from the skin, are applied for ten days. The results are indeed gratifying. I have applied this method in the treatment of my cases of cancer of the mouth during the past six months and the temporary results at least are very satisfactory.

The following case, one of Dr. Sluys', illustrates the method.

CASE REPORT

The patient, a man, 65 years old, had been a pipesmoker for years. He never had had syphilis. Three years previous to his

coming to the Institute, in August, 1925, he had noticed a spot of thickening on the lower lip, just to the right of the midline, which gradually increased in size and became ulcerated. In one year it had increased greatly in size, became ulcerated, and he had received X-ray treatment which caused a temporary recession of the ulcerated mass, but soon that was followed by a rapidly growing recurrence.

On August 8, 1925, the tumor was enormous, involving the upper and lower lip on the right side and invading the internal and external surfaces of the right cheek with almost complete destruction. The tumor was hard, inflamed, with a large ulceration at its center. Remarkably, there was no glandular involvement noted in the neck, below the jaw, or in the supraclavicular space.

The microscopic examination revealed a spinocellular epithelioma, with numerous pearls and marked karyokinetic activity.

On August 13, 1925, a wax mold of the entire region invaded and suspected was made, and on this wax mold were placed nine tubes of radium each containing twenty milligrams. These tubes each had a filtration equivalent of 2 mm. of platinum and were placed 6 cm. from one another and at a distance of 4 cm. from the skin. The apparatus was left in place for ten days.

The patient had an intense reaction over the whole region irradiated, with desquamation and epilation of the beard. This reaction lasted about two months. The tumor mass entirely disappeared, leaving the ramus of the jaw almost entirely exposed. The patient lived three years without local recurrence and then died as the result of a distant metastasis.

This was an extreme case but illustrates what can be done with small amounts of radium and high filtration, applying the radium for long periods of time.

While I cannot, at this time, report on final results with the method, the temporary results are so striking that I feel quite sure it represents an advance in the application of radium in the treatment of cancer of the mouth.

REFERENCES

(1) Colwell, H. A., and Russ, Sidney: Radium, X-ray, and the Living Cell, G. Bell & Sons, Ltd., London, 1915, p. 253.
(2) Broders, A. C.: Carcinoma of Mouth; Types and Degrees of Malignancy. Am. Jour. Roentgenol. and Rad. Ther., January, 1927, XVII, 90.
(3) Schmitz, Henry, and Hueper, William: Prognostic Value of Histological Malignancy Index and Clinical Grouping of Carcinomata of Uterine Cervix. Radiology, November, 1928, XI, 361.
(4) Schinz, H. R.: Grundfragen der Strahlenbiologie. Klin. Wchnschr., Dec. 23, 1924, III, 2397.
(5) Colwell, H. A., and Russ, Sidney: Radium, X-ray, and the Living Cell, G. Bell & Sons, Ltd., London, 1915, p. 18.
(6) Ibid: Page 135.
(7) Sluys, F.: Le Cancer (Brussels), No. 3, 1925, p. 130.

DISCUSSION

Dr. Rollin H. Stevens (Detroit): Dr. Pettit's interesting paper describes the treatment, somewhat as outlined by Regaud and the French school, now being applied very generally. We have been using that technic of radium treatment for some time and are very much in favor of it, especially for radium treatment of deep-seated growths, filtering the radium through platinum and keeping it on over a longer period of time, comparatively, and figuring out the dosage as Regaud does, in the number of millicuries destroyed per square centimeter of tissue. Dr. Pettit stated, however, that the more rapidly the tumor grows, the more mitosis we see; if we can treat the cells during mitosis we are more successful because they are more sensitive at that time. That is Regaud's theory. It does not always follow. Some tumor cells that multiply very rapidly are exceedingly resistant. We do not yet understand all the factors of radiosensitivity of the cell.

We have had one such experience very recently in treating a papillary adenocarcinoma

of the ovary. It was removed and the case referred to us within one week after its removal for deep X-ray therapy. We gave heavy doses of high voltage X-ray therapy, keeping up a saturation dose somewhat after the method of Kingery and Pfahler, and, in spite of this treatment, within two weeks that tumor had grown as large as my head, very solid, very hard, and kept on growing, and the treatment made absolutely no impression on it whatever. That tumor was absolutely radioresistant.

DR. ALDEN WILLIAMS (closing): I expected that the small doses I reported using would be attacked, and to that end I took the trouble to have the measurement of the dose noted on each lantern slide. Still, I did not hear any comment. We will continue this line of work and if we find that we are in error, we will vary the dosage or technic.

Regarding the fractional dose, I am reminded of the days when we entered the bacteriological laboratory and were told how to sterilize by using a very small amount of heat, allowing the germs and spores to grow during the next twenty-four hours, catching them again with another small amount of heat, then finishing them up on the third day. Altogether, your dose of heat for the lethal effect on your bacteria was very small indeed.

So in theory, Dr. Pettit and the foreign workers are right, and, as Dr. Francis Carter Wood says, when a method is new and is being tried out, why put your heel on it just because you have a theory of your own?

Dr. Pettit states that radium is not selective in its action: I think perhaps we cannot say that it is not any more than we can say that it is. If it is not selective (I assume this for the sake of the argument), this radium is acting all the time on the healthy cells surrounding this malignancy—these healthy cells, you know, are also dividing as are the malignant cells. That is simply a thought for us to consider.

INTRATHORACIC TUMORS[1]

CASE REPORT

By R. P. POTTER, M.D., Marshfield Clinic, MARSHFIELD, WISCONSIN

THERE are many disease conditions which may be found within the thoracic cavity and which must be considered when speaking of intrathoracic tumors. Some of these conditions are: Intrathoracic thyroid, thymus enlargement, aneurysm, carcinoma of esophagus, diverticulum of esophagus, malignant tumor of mediastinum, sarcoma and carcinoma of lung, abscess of lung, abscess of mediastinum, Hodgkin's disease, inflammatory glandular enlargement, tumor of chest wall, pleural effusion, and diaphragmatic hernia. The choice of treatment depends on the diagnosis, and, therefore, we must endeavor to be accurate.

The X-ray has proven a most valuable aid in the diagnosis of all chest diseases and yet we find that it is sometimes impossible to make a positive differential diagnosis.

In the recent literature we find a report of a case in which a mediastinal abscess was found where sarcoma had been diagnosed, and in another instance an aneurysm found where tumor had been diagnosed.

A patient recently came under our care who had been receiving high voltage roentgen therapy over a period of many months

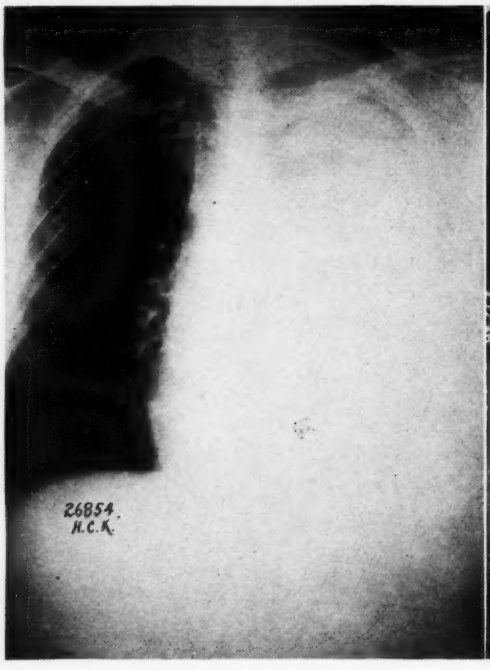

Fig. 1. Left side of chest shows density following aspiration of fluid. Tumor could be felt with aspirating needle.

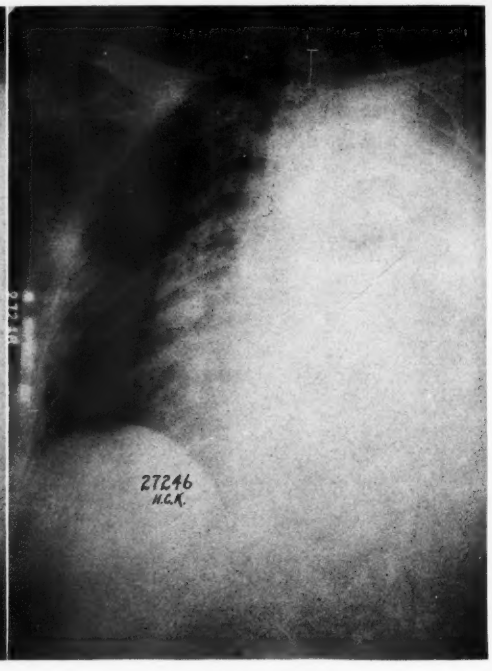

Fig. 2. Film made one month after Figure 1. Tumor had increased in size, displacing the heart and trachea to the right.

[1]Read before the Radiological Society of North America at the Fourteenth Annual Meeting, at Chicago, Dec. 3–7, 1928.

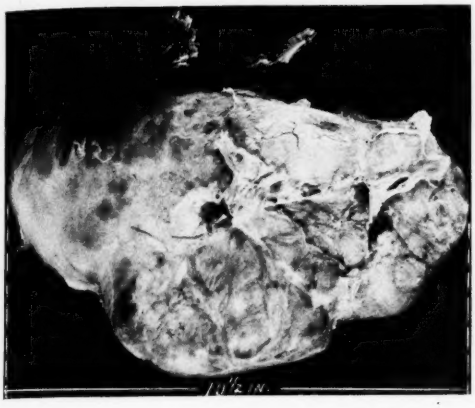

Fig. 3. Tumor that was removed (10½ inches).

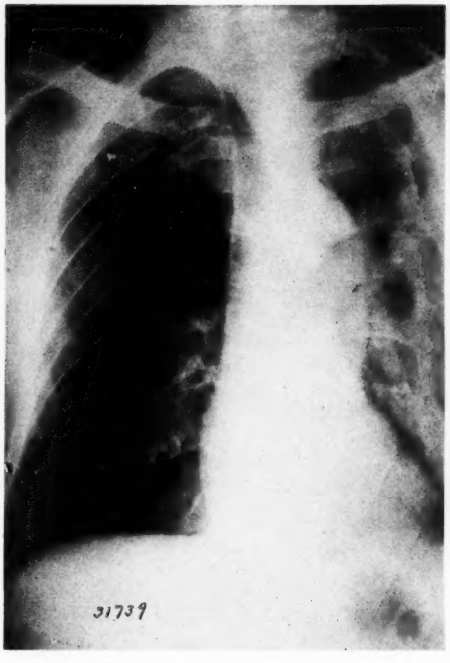

Fig. 4. Appearance of chest one year after operation. Patient well and active.

for what was thought to be a large mediastinal tumor. This proved to be an aneurysm.

Tumors of the thoracic wall have been diagnosed as syphilis when the Wassermann reaction was positive, yet the tumor was afterwards found to be a sarcoma.

The patient whose history I wish to report was at first supposed by his physician to have a large left-sided pleural effusion. The roentgen examination substantiated his diagnosis.

After a considerable amount of fluid had been aspirated the physical signs showed very little change and the roentgen examination showed the left side as cloudy as it had been before the aspiration. On further examination a solid mass could be felt with the aspirating needle and a large intrathoracic tumor was suspected.

On subsequent roentgen examination the heart and trachea were found displaced to the right to a very marked degree, the right lung being so encroached upon that apparently only about one-half its usual space was left for it.

The patient showed considerable cyanosis and was delirious at times.

An attempt at removal of the tumor was decided upon and the first of a two-stage operation done under local anesthesia on November 7, 1927. The second operation, also under local, was done November 12, 1927.

On opening the thoracic cavity it was found that the tumor filled the entire left thorax and even depressed the left diaphragm so that it was concave instead of convex. The tumor was delivered with some difficulty on account of its great size and also because of the presence of some adhesions to the posterior chest wall and lung. At this point a general anesthetic was given for a short time. There was a comparatively small pedicle, broad and narrow, which was clamped, ligated, and cut. The field of operation was closed with drainage.

The patient made an uneventful recovery and is very well to-day, over a year after his operation. The microscopic examination of the tumor showed a fibrosarcoma of low grade malignancy.

THE SEEMANN SPECTROGRAPH TELLS THE STORY

By J. W. Du MOND, Research Fellow, and ARCHER HOYT, Teaching Fellow,
California Institute of Technology, PASADENA, CALIFORNIA

BELOW are shown reproductions of two spectrograms taken with the same Seemann Spectrograph on two different makes of X-ray high voltage deep therapy equipment (Fig. 1). The Seemann Spectrograph analyzes the radiation actually given off by the X-ray tube and shows how the X-ray intensity is distributed over the X-ray spectrum. In these spectrograms, the various wave lengths appear on the scale marked at the edge. The sharp lines on the film are the characteristic spectral lines of the tungsten target.

The researches of Duane at Harvard and many other physicists have shown that an X-ray tube operating on rectified current at a steady well-defined constant voltage gives out X-rays having a sharply defined short wave length limit whose wave length is rigidly and accurately determined by the steady voltage employed. In other words, the X-ray intensity is distributed over the entire spectrum up to a certain maximum of "hardness" (or minimum wave length), beyond which no X-rays are given off, and the wave length at which the spectrum is thus cut off is shorter (harder) the higher the voltage used. The law connecting the minimum wave length (or maximum hardness) of radiation emitted with the voltage employed is a rigid physical law which has been established with great accuracy by Duane. It represents the very best that can be expected of any equipment and furnishes a "measuring stick" for comparing equipment. It also supplies an accurate means of determining by the Seemann Spectrograph, *the voltage which is actually effective in the X-ray tube.* It is obvious that a direct measurement performed on the radiation to be applied to the patient is greatly to be preferred to an indirect measurement of voltage with a sphere gap. It is hoped that the medical profession will become more familiar with the method of measuring X-ray hardness in terms of wave lengths (in Ångström units), since it is X-ray wave lengths which the patient receives and not inches of sphere gap. For the present, however, since the medical profession has based its clinical experience on volts, it is possible by the relations established by Duane and others to translate minimum wave length readings into volts. The equivalent volts of the radiation in various regions of the spectrum are, therefore, also shown on a scale accompanying the two spectrograms here reproduced.

The well-known technic of filtering X-radiations to reduce the intensity of the softer components, thus exposing the patient to a greater relative amount of hard radiation, is familiar to the profession. It should be borne in mind that no amount of filtration will give radiation which is not being emitted by the equipment. Filtration is a process of subtraction; *it adds nothing* to the original radiation. If the roentgenologist wishes to give the patient hard radiation by filtering out the softer components, it is essential that the tube shall emit an abundance of the hardest radiation that it can theoretically give at the voltage of operation. It must not be forgotten that filters cut down hard radiations to some extent, as well as soft. An X-ray filter is not a perfect sieve. It is, therefore, evident that the equipment that will give abundant intensity right up to the theoretical short wave limit (beyond which no tube can give anything) is the most desirable. In other words, a *"sharp short wave length limit"* is desirable. A sharp short wave length limit also permits

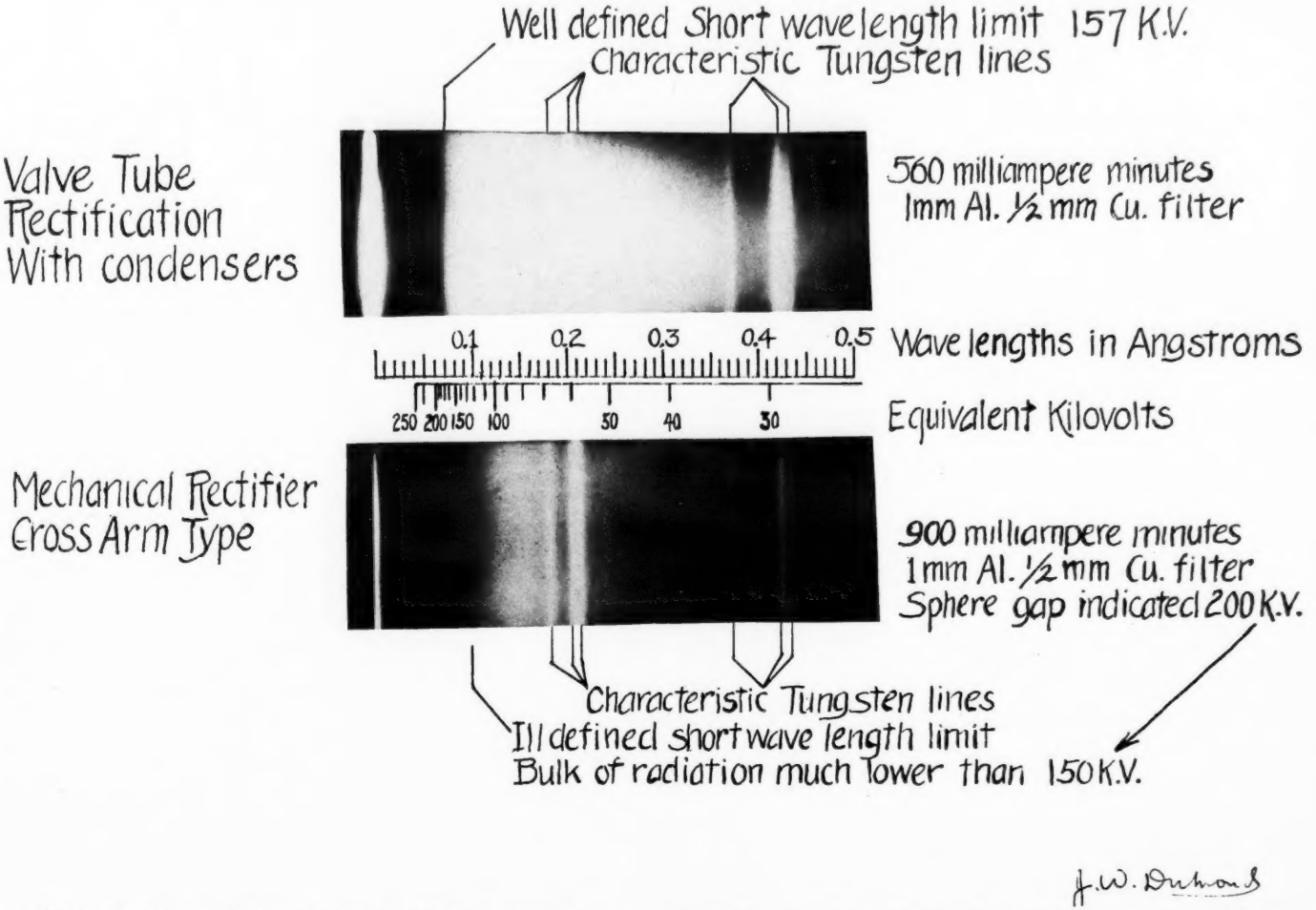
Well defined Short wavelength limit 157 K.V.
Characteristic Tungsten lines
Valve Tube
Rectification
With condensers
560 milliampere minutes
1mm Al. ½ mm Cu. filter
0.1 0.2 0.3 0.4 0.5
Wave lengths in Angstroms
250 200 150 100 50 40 30
Equivalent Kilovolts
Mechanical Rectifier
Cross Arm Type
900 milliampere minutes
1mm Al. ½ mm Cu. filter
Sphere gap indicated 200 K.V.
Characteristic Tungsten lines
Ill defined short wave length limit
Bulk of radiation much lower than 150 K.V.

Fig. 1. Reproductions of two spectrograms taken with the same Seemann Spectrograph on two different makes of X-ray high voltage deep therapy equipment. . . . The various wave lengths appear on the scale marked at the edge. The sharp lines on the film are the characteristic spectral lines of the tungsten target.

of much more accurate determination of the voltage actually operative in the tube.

The physical principles just outlined are not new: they have been known for the past decade. Unfortunately, the sales departments of some X-ray equipment manufacturers have for reasons best known to themselves discouraged in every possible way the use of precise physical measurements by the medical profession. Such procedure is worse than criminal, since it bears directly on the practice of an art on which the safety and welfare of human lives depend. *Little progress can ever be made in any field of endeavor where no precision exists.*

A word should be said as to the reason for the very poor distribution of intensity in the short wave length region (region of hard radiation) of the spectrograms taken with the mechanically rectified equipment.[1] The voltage supplied to the X-ray tube by the mechanical rectifier is far from constant. It falls to zero 120 times each second. Only for a small fraction of the total alternating current cycle is the voltage at its maximum value. It is this maximum value, nevertheless, which is measured by the sphere gap. It is highly improbable that the voltage impulses received by the tube from the mechanical rectifier are ever pure sinusoids; in fact, they are probably very jagged. This means that the bulk of the time the voltage is fluctuating at values much lower than the maximum value measured by the sphere gap. The bulk of the radiation corresponds, therefore, to radiation from a tube operated at a voltage much lower than that measured by the sphere gap.

The valve tube sets with properly designed condensers, in contrast to this, give an almost perfectly steady voltage all of the time. It is the difference between the reciprocating engine and the steady flow of steam through a modern steam turbine. This explains why the spectrogram taken with this type of equipment shows an abundance of hard radiation all the way over to the theoretical limit. This limit, as can be easily seen on the spectrogram, is sharp and definite. The physician knows what his patient is receiving because the spectrogram permits a precise measurement. The voltage as measured in this manner is 157,000 volts, no more and no less.

The roentgenologist who operated the mechanically rectified equipment whose spectrogram appears herewith, believed in good faith that his patients were receiving 200,000 volts radiation! This was partly because he had measured a maximum voltage of 200,000 on his sphere gap and partly because the manufacturers of his equipment had assured him he was getting 200,000 volts radiation! Note that the bulk of his supposed 200,000 volts radiation *after filtration* is much softer (longer in wave length) than that obtained by the roentgenologist with the valve tube equipment who knew definitely that he had 157,000 volts radiation. (A calibration curve was furnished to the latter man, and he could set his equipment to give as high as 180,000 volts if he wished.)

In view of the results obtained by the authors of this paper, they feel that they cannot too strongly recommend to all radiologists using deep therapy equipment that they make precise measurements of X-ray output from time to time to insure against all uncertainty as to the radiation given the patient. It is not only important that the radiation in a given outfit should at all times be the same, but also, that all outfits should be standardized so as to make reports of clinical experience by all members of the profession comparable and precise. Only thus can the practice of roentgenotherapy attain its full share of scientific precision. Spectrograms and spectrographic voltage calibration are important and so also

---

1"Cross-arm type mechanical rectifier."

are measurements of effective wave length, depth dose, isointensity curves with the water phantom, and measure of absolute intensities in roentgen units.

Experimental Investigations on the Healing of Electrocoagulated Wounds Treated by Radium. O. Schürch and E. Tschudi. Strahlentherapie, 1929, XXXII, 143.

The authors studied the healing of wounds in rabbits produced either by knife or by electrocoagulation. The knife wounds healed quicker; if both types of wounds received radium radiation, the knife wounds healed much slower, while the healing time of the electrocoagulated wounds was not influenced. Their healing time was less than that of the irradiated knife wounds. In malignant diseases, it seems advisable, therefore, to remove the tumor by coagulation if post-operative radium therapy is intended; this would assure a short healing time.

E. A. Pohle, M.D., Ph.D.

Further Experience with Roentgen Therapy in Psychiatric and Neurological Diseases: 1. — Mongolism. W. v. Wieser. Strahlentherapie, 1929, XXXII, 215.

W. von Wieser suggested, several years ago, a treatment of mentally abnormal children with roentgen rays. In this profusely illustrated article covering about eighty pages, he gives a detailed report of his experience in the treatment of mongoloid children. While he does not claim that his method will lead to complete cure, it seems very desirable to give it a fair trial. If his results can be duplicated, there should be a wide field for cooperation between neurologist and radiologist. The paper is recommended for study in the original.

E. A. Pohle, M.D., Ph.D.

THE VALUE OF THE BI-PLANE FLUOROSCOPIC SCREEN IN THE REDUCTION OF FRACTURES AND THE REMOVAL OF FOREIGN BODIES, ENERGIZING BOTH TUBES AT THE SAME TIME

By L. G. McCUTCHEN, M.D.
Roentgenologist, St. Louis City Sanitarium and St. Mary's Infirmary, St. Louis

THE writer wishes to emphasize the value of the bi-plane fluoroscopic screen in the X-ray Department, and its superiority for fracture and foreign body work over the single screen, which is at the present time generally used.

Those of us who are endeavoring to keep abreast with the rapidly moving scientific age in which we live are constantly on the alert for those time- and labor-saving aids to our work which will combine the greatest degree of accuracy and efficiency; but because of the many fads and fancies which are ever coming and going in the practice of medicine, the majority of us are slow to adopt these aids until time and usage have determined their true value, and their right to retain a permanent place in our work.

The adoption of the bi-plane fluoroscopic screen, despite its value, is perhaps hampered by the electrical and radiation hazards which, we are forced to concede, have to be taken into consideration at this time. However, these hazards are not so great when the apparatus is in the hands of a skilled radiologist.

The bi-plane fluoroscopic screen consists of two fluoroscopic screens joined at right-angles, one for the antero-posterior and the other for the lateral view. The two views can be obtained with the regular radiographic and fluoroscopic table, by energizing both tubes at the same time. For this purpose, the tube above the table is covered with a black lead glass fluoroscopic bowl, which is light-proof, and the tube-stand rotated so that the ray will be parallel with the table from the side (Fig. 1). Use one millimeter of aluminum to close out the light from the tube and to filter the ray. Cone the ray down to within the limits of the fluoroscopic screen and keep it thus limited, because if the lateral ray strikes the upper screen, the antero-posterior image will be blurred. The ray from the tube under the table should also be confined to the limits of the fluoroscopic screen. In addition to giving a clearer vision, the danger of too much exposure from the rays of two tubes to both operator and patient is greatly lessened.

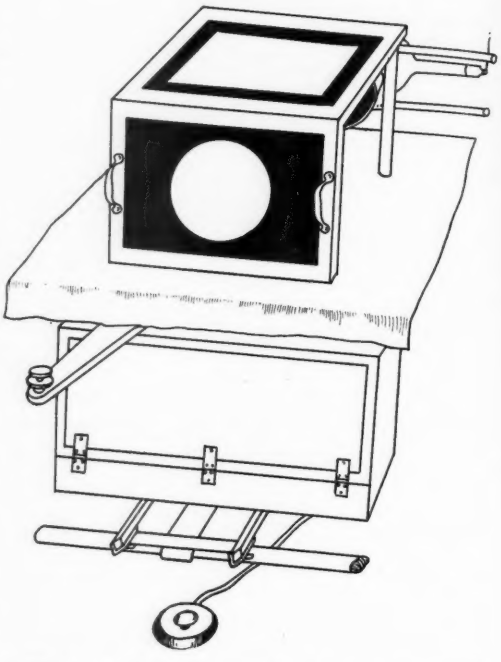

Fig. 1. Bi-plane fluoroscopic view with ray coned down to limits of screen.

Most cases of foreign body in the lung are in small children. Here the usual penetration for both views can be used and little or no difficulty experienced in visualization with children up to ten years of age. In

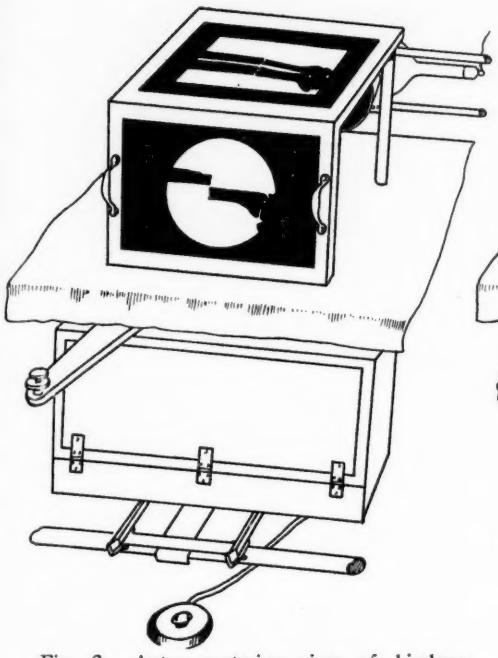

Fig. 2. Antero-posterior view of bi-plane screen, showing fragments apparently in good position, while the lateral view reveals posterior displacement of fragments.

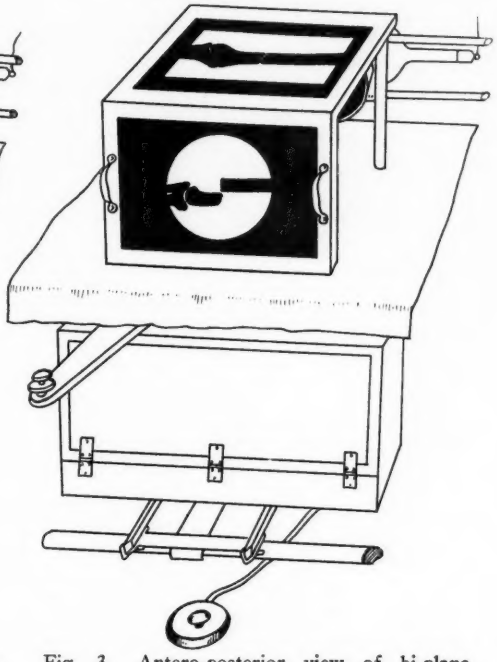

Fig. 3. Antero-posterior view of bi-plane screen, showing fragments apparently approximated, while lateral view shows posterior displacement.

the adult, however, it will be found necessary to increase the penetration in the lateral view in order to obtain a clear view of the foreign body and its position with relation to the bronchoscope. It is suggested that this be done intermittently and only one tube energized at a time, as a precautionary measure against this increase in penetration.

The bi-plane fluoroscopic screen will also be found to be of great help in extremity work, both in the removal of foreign bodies and in the setting of broken bones, and no difficulty should be had with visualization.

It is, of course, not necessary to keep both tubes simultaneously energized continuously during any operation. The value of the lateral view lies in the fact that it serves as an immediate check on the antero-posterior view, and it should be used only when it is needed.

As everyone who has done work of this kind knows, the fragments of a broken bone may appear in good alignment in the antero-posterior view, while the lateral view may show considerable displacement, or overriding. In the removal of foreign bodies, it is also true that from the antero-posterior view it may appear that our instrument is touching the object we are seeking, while the lateral view may show that the instrument is several centimeters distant.

Then we may say that the superiority of the bi-plane fluoroscopic screen lies in the efficiency afforded us by the two instantaneous views, one checking the accuracy of the other, and making possible a decrease in the time interval of the operation, as well as exposure to the ray.

In conclusion, I wish to say that the bi-plane fluoroscopic screen is a step ahead, and calls for an improvement in the safety provisions of the X-ray apparatus now in use.

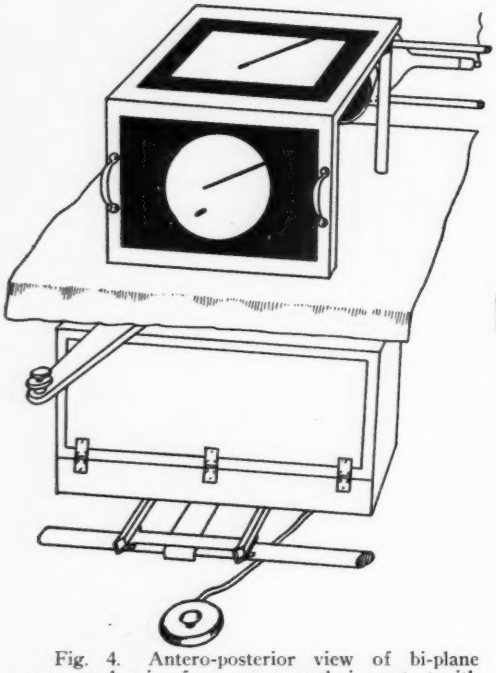

Fig. 4. Antero-posterior view of bi-plane screen, showing forceps apparently in contact with foreign body, while the lateral view shows them to be several centimeters apart.

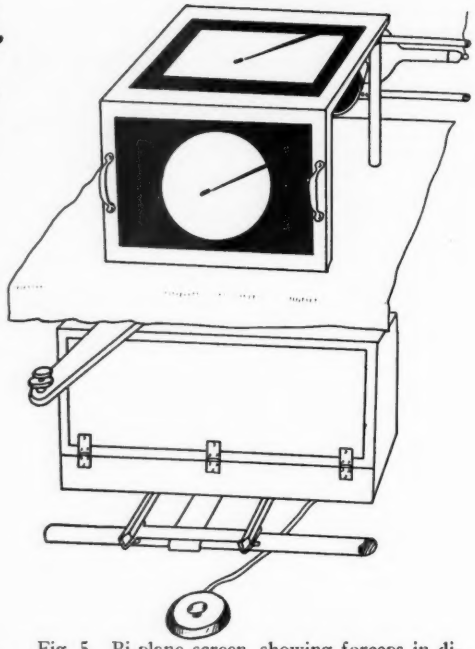

Fig. 5. Bi-plane screen, showing forceps in direct contact with foreign body in both views.

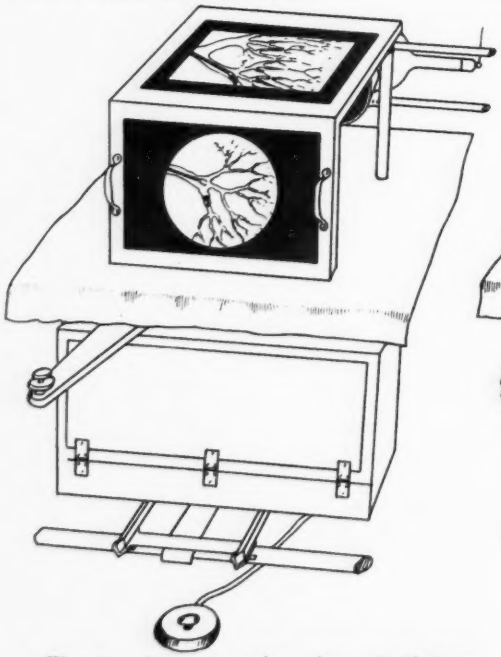

Fig. 6. Antero-posterior view of bi-plane screen, showing bronchoscope apparently touching foreign body, while the lateral view shows them to be some distance apart.

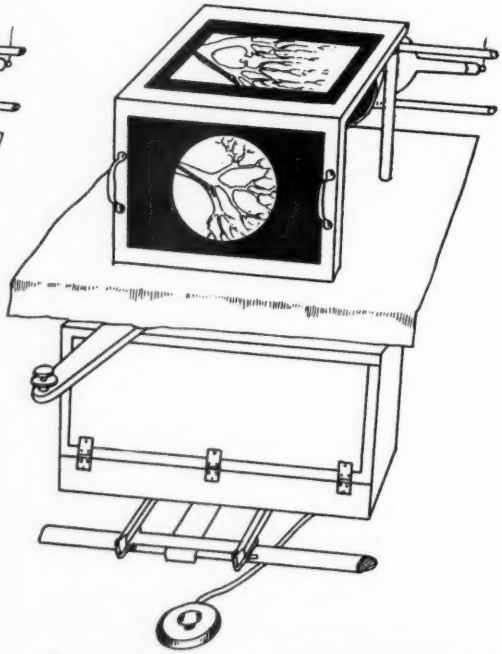

Fig. 7. Bi-plane screen, showing bronchoscope in direct contact with foreign body in both views.

The oil-immersed unit provides this safety by eliminating exposed wires. It consists of a tube above the table which can be used for radiographic work, or rotated to the side for lateral fluoroscopy. But the equipment will not be complete for fracture and foreign body fluoroscopic work until two tubes, one above and the other below the table, can be had. When this type of apparatus is perfected, as I believe it will be, so that it can be used in connection with the bi-plane fluoroscopic screen, there can be no doubt that we shall have a mechanical combination providing a greater degree of safety, accuracy, and efficiency than we have heretofore known in the X-ray Department, and that this combination will prove of invaluable aid both in the reduction of fractures and in the removal of foreign bodies.

CASE REPORTS AND NEW DEVICES

CONGENITAL ABSENCE OF RADIUS, WITH OTHER ABNORMALITIES

By A. E. BLACKETT, M.D., C.M., New Glasgow, Nova Scotia, Canada

The case herein reported is that of a female child aged six months. Medical advice was sought because of a deformity of the right hand.

Family history: The mother was tuberculous and entered a sanatorium shortly after the birth of the child.

Physical examination: The right hand was acutely bent to the radial side of the forearm and pointed upward at an angle of about forty-five degrees. It could, by traction, be made to assume a normal position. There was absence of the thumb. The child was bright and well nourished and could grip with the hand.

X-ray examination: Complete absence of the radius in the forearm, with bowing of the ulna toward the radial side. There was also absence of the thumb metacarpal and phalanges. Thinking there might be further skeletal abnormalities, the chest was examined and a marked right-sided widening of the mediastinal shadow was found, which was diagnosed as enlargement of the thymus.

One writer (1), in reviewing the literature, states that the radius is the fourth most common bone to be affected in congenital abnormalities, the fibula being first, the tibia second, and the ulna third.

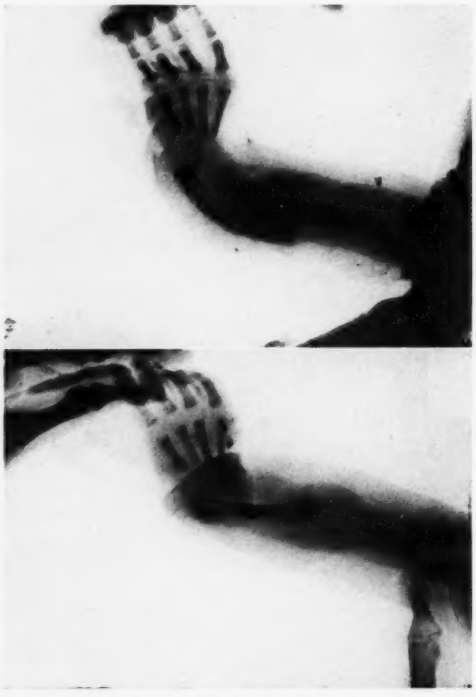

Fig. 1. Two views showing absence of radius and thumb bones.

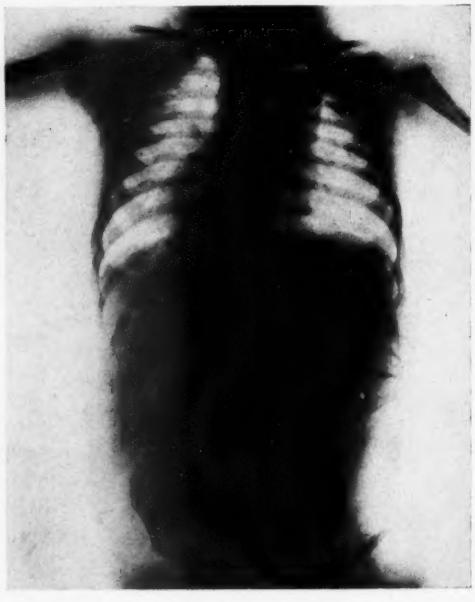

Fig. 2. Right-sided enlargement of the thymus.

REFERENCE

(1) SHANDS, A. R., JR.: Congenital Absence of the Femur, Patella, Tarsal Scaphoid, and Ischium, Associated with Other Abnormalities. Am. Jour. Roentgenol. and Rad. Ther., June, 1928, XIX, 531.

SUBASTRAGALOID DISLOCATION OF THE FOOT

REPORT OF CASE

By JOSEPH F. ELWARD, M.D., and LAURENCE S. OTELL, M.D.,

Roentgen-ray Department of Sibley Memorial Hospital, WASHINGTON, D. C.

Subastragaloid dislocation of the foot is a condition sufficiently rare to warrant the report of this case.

Shands (1), in describing a case which has come under his observation, has reviewed the literature extensively and has found only 139 such cases, including his own. These are divided as to type into: (1) The inward type, which comprises 55.4 per cent of the total number reported; (2) the outward type, which comprises 33.1 per cent; (3) the backward type, comprising 7.2 per cent, and (4) the forward type, 3 per cent. The injury was found to be six times more common in males than in females. The age incidence shows the injury most common in the third decade: 33 per cent of the cases reported were in this period.

CASE REPORT

R. K., male, age 35, white. *Complaint:* Deforming injury to right foot.

Fig. 1. Subastragaloid dislocation of right foot.

Past history and family history: Irrelevant.

Present injury: Was driving an automobile at great speed, while said to be under the influence of alcohol. Upon seeing a heavy truck ahead, he attempted to push vigorously on the foot brake, at the same time crashing with great force into the rear of the truck.

Physical examination (one hour after injury) shows a well nourished, muscular man, five feet and six inches in height, and weighing 165 pounds. There is a marked deformity of the right foot, a prominence in the region of the external malleolus, and a bulging on the inner aspect of the foot. There is considerable inversion and some plantar flexion. The ankle is markedly swollen and tender, and there is excruciating pain on any attempt at manipulation.

Roentgen examination (one and one-half hours after the injury) shows an inward dislocation of all of the tarsal bones except the astragalus, which occupies its normal position between the two malleoli. There is also some anterior displacement of the astragalus on the os calcis, and a piece of bone lying in the position of an os trigonum, but which, because of its size and position, is evidently a chip of bone broken from the posterior aspect of the astragalus. There is no other evidence of fracture of any of the tarsal bones or of the tibia or fibula.

Treatment: Under gas oxygen anesthesia, Dr. H. A. Wood easily reduced the dislocation by forward traction and forceful eversion. A plaster cast extending from the knee to the toe was applied. At the end of three weeks the cast was removed. At the end of one month the patient bore weight on the foot. Normal function returned gradually and, at the present time, eighteen months after the injury, the patient has a normally functioning ankle.

REFERENCE

(1) SHANDS, A. R., JR.: Jour. Bone and Joint Surg., April, 1928, X, 306-313.

A COOLING SYSTEM FOR USE IN HOT CLIMATES

By C. J. MARSHALL, M.D., SANFORD, FLORIDA

The many radiologists in the South who have had to contend with the troubles of development, and fogged films incident to the difficulties of keeping the solutions at the required temperature of 65 degrees Fahrenheit, which is the best for bringing out the detail of their roentgenographs, will doubtless be interested to know of a method which has proven itself absolutely satisfactory in the writer's Florida laboratory.

The temperature of the tap water in most of the Southern States in the summertime is such as to absolutely melt the gelatin from its base, unless some cooling method is used. Ice is very unsatisfactory, as is well known, unless large quantities are used in a separate compartment from the developing tank, the running water being brought in through a cooling coil; and then a thermostatic mixing device must be used to keep the temperature right.

Having tried various types of electrical refrigerating devices in the past, I found technical difficulties with all of them, until one was brought out recently by the General Electric Company in which the entire device is self-contained in one single unit, which may be placed on the top of the container to be chilled. I then had a combination built for my laboratory, a view of which is shown in Figure 1, indicating the simplicity and convenience of the outfit, in actual use in my dark room.

The master tank was built on the lines of the ordinary household ice-chest by a local cabinet maker. It is constructed of wood, with cork insulation, and lined throughout

with 1/16 inch lead, since lead withstands the action of the acids used in the solutions better than copper or other materials.

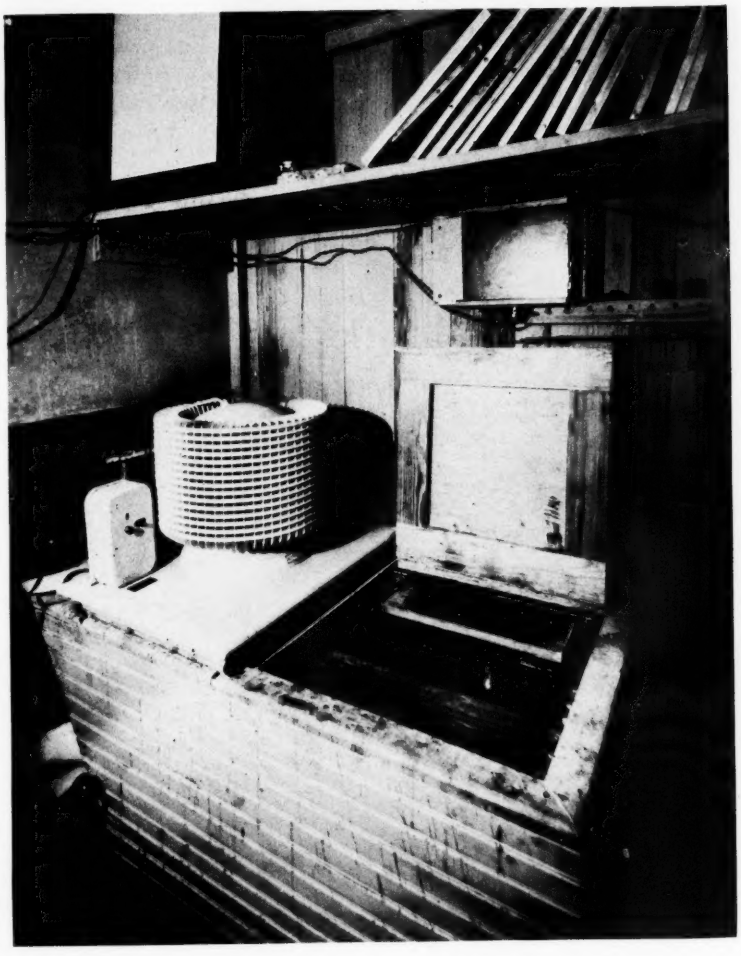

Fig. 1. Electrical refrigerating device as installed in a dark room.

It is fitted with the ordinary bath-tub drain and overflow pipes, for cleaning the tank and regulating the water level. The cooling device is set on the left-hand end of the top, with the cold coil immersed in the water. The right-hand end is fitted with a hinged cover, under which are the five-gallon Impermo fiber unit tanks for the developer and hypo solutions, with space between these tanks for rinsing and washing the films.

The water inlet to the master tank consists of about twenty-five feet of ¼ inch copper tubing, wound around the cold coil of the refrigerating device, so that the running water which is used for washing the films is pre-cooled before entering the tank.

The machine has a thermostatic control which may be set to keep a predetermined

constant temperature, as desired, or it may be operated manually, turning it on when necessary to chill the solutions. It is noiseless, odorless, and requires absolutely no attention in the way of lubrication. It is run with an extension cord from the ordinary light socket, requiring no special wiring to install. Being so compact, it requires very little space in the dark room, besides allowing the dimensions of the master tank to be cut down to a minimum.

After having thoroughly tried out various other methods of keeping the solution temperatures correct, I feel that at last I have found a satisfactory one, and I am passing on the idea for the benefit of any other radiologists who may be having troubles of their own.

EDITORIAL

M. J. Hubeny, M.D. . . . . *Editor*

Benjamin H. Orndoff, M.D.
John D. Camp, M.D. } *Associate Editors*

Contents of RADIOLOGY copyrighted by the Radiological Society of North America.

CANCER OF THE CERVIX UTERI[1]

I. FREQUENCY OF CANCER OF THE UTERUS

Forty per cent of cancers occurring in women are cancers of the cervix uteri. Inasmuch as women are the subject of cancer to a greater degree than men, cancers of the uterus cause more than one-twentieth of all deaths from cancer.

II. CANCER AT ONE STAGE OF ITS EXISTENCE CURABLE

If it could be impressed upon the lay public, and definitely appreciated by the profession, that cancer in its incipiency is a local disease which may be destroyed, eradicated, and cured, our propaganda for early diagnosis of carcinoma would be an easy matter.

III. CANCER OF THE CERVIX UTERI IN ITS EARLY STAGES OFTEN OVERLOOKED

Cancer of the cervix uteri, for obvious reasons, in its early stages is often overlooked. No amount of instruction in regard to the early signs of cancer seems to remedy this unfortunate oversight.

IV. PERIODIC HEALTH EXAMINATIONS

"Periodic health examinations" is an old story, but, like the Golden Rule or the Sermon on the Mount, bears constant repetition. Especially should every woman over thirty years of age have a thorough pelvic examination once each year. This annual audit should be the occasion for a complete physical examination. Especially is this important in women who have borne children. Thirty years ago, Dr. Howard A. Kelly made what at that time was a startling assertion—that every woman over forty years of age, especially women who have borne children, should have a thorough, complete pelvic examination at stated intervals one or more times during the year. This statement, which now seems commonplace, was an early beginning of the intense campaign for periodic health examinations in which at the present time we are all engaged.

V. PESSIMISM IN REGARD TO CURE OF CANCER

Pessimism in regard to the cure of cancer on the part of the profession and the public should be transformed into an optimism in regard to the cure of cancer. If every individual, may I restate, could be convinced that cancer at some stage is curable, and then made to realize that a thorough health examination once a year by a competent diagnostician will discover the earliest signs, our problem would be an easy one.

VI. THE CURES

While we are searching for the cause and a specific cure for cancer, it must be emphasized that surgery in some form, and irradiation in some form, are the only cures of early cancer, and that either of these forms of treatment applied to cancers of all stages can materially modify their course

[1]Presented before the Radiological Society of North America, at the Fourteenth Annual Meeting, at Chicago, Dec. 3–7, 1928.

and extend life. In other words, every victim of cancer should be furnished with either one or the other form of treatment as a palliative measure if not for positive cure.

VII. SURGERY *versus* RADIATION

I have been impressed during the last two years, in observing the use of these competitive treatments, with the growth of popularity, based on apparent results, of radiation as an adjunct to surgery, and as an exclusive treatment. At the International Cancer Conference of the British Empire Cancer Campaign, held under the auspices of the Royal Society of Medicine, in London, during July of this year [1928], I was particularly impressed by reports of the results of radiation in comparison with surgery, especially in the treatment of cancer of the cervix and cancer of the breast.

At a recent meeting of the American College of Surgeons, a symposium on carcinoma was conducted by its Department of Clinical Research under the leadership of Dr. Robert B. Greenough, Chairman of the Committee on the Treatment of Malignant Diseases with Radium and X-ray. A prominent position was taken regarding radiation as an adjunct or as an independent treatment for carcinoma. Dr. Greenough's committee, since January, 1922, has been making an intensive study of carcinoma of the cervix and of the breast, and has recently begun a study of cancer of the mouth. This work is being carried on in a strictly scientific manner, and an accurate record kept of all cases in which doubtful diagnoses are eliminated and careful observation and follow-ups exacted. Though there are now three groups in which treatment has extended beyond the five-year period, no positive pronouncement has been made in regard to a preference in treatment; but radiation, with its improved technic, holds a prominent position.

In this same symposium Dr. George W. Holmes, of Boston, made a suggestive statement in his paper on "Present Status of Radiation Treatment in Carcinoma of the Breast." He compared statistics of cases reported by Daland that had received no treatment, and those by recognized clinics in which radiation, or radiation supplementing operation, had been utilized. Even in cases considered inoperable, a definite palliative result was demonstrated, with an extension of life, when surgery and radiation were employed. This emphasizes the importance of an optimistic view of the subject of treatment of cancer. And in my opinion no victim of carcinoma, even though the condition may be greatly extended or inoperable, should be allowed to remain without treatment, as, for obvious reasons other than the prolongation of life, such patients may receive definite palliative and mental comfort.

Again in this same symposium I was much impressed by the paper on "Radiation Therapy in Carcinoma of the Cervix Uteri," by Dr. George Gray Ward, of New York. He said: "The question to-day is, Can radiation obtain the same results in treating cancer of the cervix as can be obtained by the Wertheim operation? If the result of the radium treatment is as effective in the number of patients permanently cured, radium, obviously, has a decided advantage, inasmuch as it has practically no operative death rate." He calls attention to the fact that there are very few large clinics using radium alone for operable cancers of the cervix. Consequently, only a few series of operable cases of carcinoma of the cervix treated with radium are reported after the five-year period, compared with the large number of cases operated upon radically and observed for a period of five years or longer.

Dr. Ward's report is from the Woman's Hospital of New York, and embodies the re-

sults obtained by irradiation on all cases of cancer of the cervix; but especially does the report show results of irradiation in operable cases in the ten years that such treatment has been in vogue. He also refers to two studies—one in England by Dr. Janet E. Lane-Claypon, published by the Minister of Health in England, and the second by Dr. J. Heyman, of the Radiumhemmet of Stockholm. He calls attention to the fact that these two organizations had a primary mortality of only 1.59 per cent. He says: "We are now able to report on all cases treated in 1919, 1920, 1921, and 1922, and the first five months of 1923. Our records, and follow-up and result cards have been audited by professional statisticians, and the figures as presented to you have been compiled by them and certified as correct. We have included all cases of carcinoma that have originated in the cervix, and have not been operated upon or treated with radium elsewhere." In all classes, apparently operable and inoperable, Ward presents 134 cases treated by radium, of which 126 have been traced: living 31; living after five years, 23.1 per cent. Selected cases, apparently operable, 32 treated: traced 30; living 17; percentage of cases traced 56.7 per cent; cases living after five years, 53.1 per cent. In these cases the mortality of the primary treatment was 0.44 per cent, less than one-half of 1 per cent. He quotes from all clinics a five-year cure of 18 per cent. Radiological treatment cures 16.3 per cent. From all clinics they reported an immediate operative mortality of 17.2 per cent, with a primary radiological mortality of less than 2 per cent.

To me, the impressive thing about this report is the fact that in cases treated by radical surgical procedure, one would have to deal in the average clinic with an immediate mortality of from 5 to 10 per cent, against practically no mortality for those treated by radiation. Is it not proper to urge upon this distinguished body the necessity of supporting research committees, such as the Committee on the Treatment of Malignant Diseases with Radium and X-ray of the American College of Surgeons, of which Dr. Robert B. Greenough, of Boston, is Chairman, and the Registry of Bone Sarcoma of the College, of which Dr. Dallas B. Phemister, of Chicago, is Chairman? Each of these committees is endeavoring to record a large series of cases, carefully studied and treated by surgery or radiation, so that from year to year we may have a reliable basis on which to estimate the value of the respective treatments.

In discussing the problem of cancer, its diagnosis and its treatment, we must insist upon careful diagnostic methods. The discovery of incipient carcinoma requires very acute observation by a series of specialists. It does not seem reasonable that any one observer can discover the earliest signs of incipient carcinoma with the same degree of accuracy as a specialist who is trained in the accurate observation of a particular portion of the body. In other words, at least we must insist that before treatment—either surgery or radiation—is instituted, so far as possible an accurate diagnosis shall have been made by a trained and licensed physician.

AN EDUCATIONAL PROBLEM

As in all educational movements, the subject of recognition and treatment of cancer, in relation to the profession and the public, is an educational problem. There is no one thing that militates against this campaign more than complacency—complacency on the part of teachers, complacency on the part of the profession, and complacency on the part of the public.

During this century the profession of medicine has urged the importance of the early recognition of cancer on the part of

the profession. This was emphasized in my presidential address, presented at the recent annual meeting of the American College of Surgeons in Boston, as follows:

" . . . Special semi-public organizations, conspicuously the National Tuberculosis Association and the American Society for the Control of Cancer, the former twenty-four years ago, the latter sixteen years ago, began to urge periodic health examinations so that the signs of the respective disease in which they were interested might be discovered early. Later their example was followed by the American Child Health Association, the American Social Hygiene Association, the American Heart Association, *et cetera*. Naturally it soon became obvious that preventive medicine could be more systematically advanced if the pub'ic were educated to accept a comprehensive periodic examination that would reveal the early signs of any disease instead of some particular disease. . . .

"These demonstrations, with examinations for special diseases, gave great impetus to the propaganda in favor of all-round periodic examinations. In 1919 and 1920 the American College of Surgeons organized its sectional meetings, since which time it has held sessions in practically every state of the United States and every province of Canada. The principal innovation is the carefully planned meeting for the laity at which, in simple language, the lay man and woman are given information on the fundamentals of scientific medicine, and especially the advantage of periodic health examinations.

"The Gorgas Memorial Institute of Tropical and Preventive Medicine was organized in 1921. As the activities of the Memorial have developed, it has more and more urged upon the public the importance of seeking an annual health audit by the family physician.

"In May, 1922, the Trustees of the American Medical Association urged the members of organized medicine, through the county medical societies, to encourage such examinations. Blanks were developed by the Association for that purpose in May, 1923, and in 1925 the Association also prepared for the use of physicians a comprehensive manual which contains very useful hints on the method of conducting these examinations. . . . "

This progressive campaign should not fall on complacent ears. It should be heeded by all interested in cancer, including the lay public, the physician who must recognize the disease, and the hospitals in which cancer can best be treated.

FRANKLIN H. MARTIN, M.D.

THE ANNUAL MEETING OF THE SOCIETY

The Fifteenth Annual Meeting, held in Toronto during the first week of December, 1929, was a gathering of international scope and the attendance was large. The Local Committees, under the able leadership of Dr. Gordon E. Richards, Professor of Roentgenology of the University of Toronto and Head of the Department of Roentgenology of the Toronto General Hospital, carried through to completion the intricate plans necessitated by a meeting of this size and exacting requirements.

The Society, speaking through its officers and Executive Committee, has expressed its gratitude to all who have contributed toward this achievement.

Dr. Manuel Madrazo, President of the Radiological Society of Mexico, honored the Society by his presence.

The offer made by the Chemical Foundation to back the Society's Journal, RADIOLOGY, in the publication of papers on all manifestations and applications of radiant energy was accepted.

ROBERT J. MAY, M.D., of Cleveland, President of the Radiological Society of North America.

BESTOWAL OF AWARDS BY THE SOCIETY

During the proceedings which have come to be known as the Society's Annual Banquet, Certificates of Award were bestowed for excellence in the Scientific Exhibit. These were adjudged in two classes: exhibits by individuals and exhibits by those availing themselves of the assistance of the institutions with which they are associated.

In the first group, the awards were as follows:

DR. LLOYD BRYAN and DR. HOWARD E. RUGGLES, San Francisco: "Non-tuberculous Chest Lesions."

J. L. WEATHERWAX, M.A., and DR. BERNARD P. WIDMANN, Philadelphia General Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia: "Routine Clinical Application of Physical Measurements in Radiation Therapy."

OTTO GLASSER, PH.D., Cleveland Clinic Foundation, Cleveland: "Prof. Roentgen and the First Year of Roentgenology."

In the second group, the awards were as follows:

DR. HENRY K. PANCOAST and DR. TEMPLE FAY, University of Pennsylvania, Philadelphia: "Encephalography."

DR. GORDON E. RICHARDS, DR. W. H. DICKSON, and DR. A. C. SINGLETON, Toronto: "Radiological Studies."

DR. CHARLES G. SUTHERLAND, Mayo Foundation, Rochester, Minn.: "Roentgenographic Educational Exhibit."

The recipients of these honors may justly take pride in their achievements, since the Scientific Exhibit at this, the Fifteenth Annual Meeting of the Radiological Society of North America, was the largest exhibit of this character ever held by a scientific society.

NINTH NATIONAL CONGRESS OF MEDICAL RADIOLOGY

The ninth Congresso Nazionale di Radiologia Medica will be held in Turin, Italy, in May, 1930, under the chairmanship of Prof. M. Bertolotti.

It is the purpose of the Chairman to provide an up-to-date discussion of all questions pertaining to the two topics on the program, both of which are of especial clinical importance. The first topic is "The Radiologic Diagnosis of Intracranial Tumors" and will be entrusted to two speakers, Nuvoli, of Rome, who will treat the subject of normal cranial radiographic anatomy, and Montanari, of Ancona, who will deal with the part pertaining to the radiologic observations on basilar tumors of the brain.

The second topic concerns "The Treatment of Blood Diseases by Means of Irradiations," and has been assigned to two speakers, Siciliano, of Florence, and Bignami, of Pavia, who will be aided by the eminent clinician of Pavia, Professor Ferrata, who will give in a lecture an exposition of the more important clinical questions pertaining to the subject.

The topics selected and the persons chosen to present them furnish assurance that the scientific work of the Congress will be of the greatest interest and will permit of most profitable discussions.

In accordance with the decision reached, at the session of the Congress only those communications that pertain to the topics selected will be discussed. In addition, in order that every communication may be properly developed, the Chairman calls attention to the fact that no communication will be accepted unless *the title and an abstract shall have been received during the month of February, 1930.*

A large exhibit of radiologic apparatus and equipment manufactured in Italy and in foreign countries will be held.

BOOK REVIEW

RADIUM TREATMENT OF CANCER. By STANFORD CADE, F.R.C.S. (Eng.), Assistant Surgeon, Joint Lecturer on Surgery and Teacher of Practical Surgery, Westminster Hospital; Late Hunterian Professor and Arris and Gale Lecturer, Royal College of Surgeons of England. Published by William Wood & Company, New York, 1929. Pages 158. Price $5.50.

An English author, Stanford Cade, in his book "Radium Treatment of Cancer," has produced a notable addition to radiological literature. Radiologists everywhere will appreciate his enthusiasm and his concise presentation and technic of application in different regions of the body. This work should also prove a revelation to the surgeon. It is particularly interesting as it represents the viewpoint of a surgeon, who, with his colleagues at Westminster Hospital, has employed radium therapy for the last five years and realizes its potentialities. The author states in his preface: "I am primarily a surgeon, and radium therapy is only an effective weapon in the armamentarium available for the treatment of patients afflicted with cancer. . . . Radium needs a surgery of access and surgery needs radium, if the best is to be given to the patient." His enthusiasm is shown by the further quotation: "The possibilities of radium treatment are appreciated by all the surgeons of Westminster Hospital to such an extent that it has become a daily routine, and some forms of cancer, such as tongue, lip, palate, and brain, are now entirely treated by radium. We feel confident that in a few years' time the same will be said about cancer of the breast and uterus."

Cancer in different regions of the body is discussed and technic and dosage are outlined. The dosage advocated in all instances consists of prolonged irradiation with small amounts of radium, based on the teachings of the Radium Institutes of Paris and Brussels.

The author's experience is not sufficient to warrant statistics, but selected cases are recounted in detail. The book is concise and well written. No historical data are given. The physics of radiotherapy is touched upon very lightly. Abundant references are given, the work is well indexed, and the illustrations, photomicrographs, and colored plates are especially good.

ABSTRACTS OF CURRENT LITERATURE

INDEX TO ABSTRACTS IN THIS ISSUE

ARKUSSKY, J. On Iodin Excretion by the Organism under the Influence of Roentgen Irradiation 83
BANCROFT, FREDERIC W. Advisability of Roentgenographing Sinus Tracts for Diagnosis..... 84
BARTELINK, D. L. Stereography of the Chest..... 92
BORM, A. (*with* CRAMER, H.)..... 92
BOWEN, DAVID R. Acute Massive Collapse (Atelectasis) of the Lung..... 86
BUTTNER, KONRAD. Current and Potential Characteristics and Fatigue Symptoms in Cadmium Cells Filled with Argon..... 89
COLEY, BRADLEY L. (*with* COLEY, WILLIAM B.)..... 85
COLEY, WILLIAM B., and COLEY, BRADLEY L. The Generalized Type of Osteitis Fibrosa Cystica, with Report of Case..... 85
COSTOLOW, WILLIAM E. (*with* SOILAND, ALBERT, and MELAND, ORVILLE N.)..... 91
CRAMER, H., and BORM, A. The New Tube Stand for Metalix Therapy Tubes..... 92
DAUTWITZ, FRITZ. Contribution to the Effect of Radium on Glycosuria in Carcinoma Cases under Irradiation..... 90
DUBOWY, E. D. Results of the Use of Roentgen Rays in Polycythemia 87
FELDWEG, PAUL. Experience with Continuous Dosimetry in Gynecological Deep Therapy..... 87
FRIED, CARL. A New Tube Stand in Connection with the Metalix Therapy Tube..... 92
GLOCKER, R., HAYER, E., and JUNGLING, O. On the Biological Effect of X-rays of Different Quality when the Doses are Measured in r-units 89
GOLDMANN, R. On the Roentgen Therapy of Acute Inflammations in the Inner Ear..... 91
GRAUER, S. Contribution to the X-ray Treatment of Ozena..... 84

GUTHMANN, H., and SCHOL, W. Calcium, Pregnancy, and Light 91
HASE, H., KUESTNER, H., and PIEPENBORN, J. Errors in Measurements with the Standard Instrument (Kuestner) Due to Improper Handling 84
HAYER, E. (*with* GLOCKER, R., and JUNGLING, O.) 89
HELL, FRANZ. Contribution to the X-ray Treatment of Pneumonia 83
JARCHO, JULIUS. Uterosalpingography. Third Communication: Safety of the Method, Compilation of Reports of Untoward Results, Contra-indications, Survey of Recent Literature, Discussion of Technic and Therapeutic Applications, and a New Syringe with Manometer Attachment 85
JUNG, G. (*with* MARTENSTEIN, H.) 90
JUNGLING, O. (*with* GLOCKER, R., and HAYER, E.) 89
KRÖNING, F. (*with* SEULBERGER, P., and SCHMIDT, W.) 86
KUESTNER, H. (*with* HASE, H., and PIEPENBORN, J.) 84
LACASSAGNE, A. Results of Radiation Therapy in Adeno-epithelioma of the Uterus 91
LIEBERSOHN, J. On the Treatment of Inflammatory Diseases with Roentgen Rays in Small Doses 87
MARTENSTEIN, H., and JUNG, G. On the Radiation Therapy of Scleroma 90
MELAND, ORVILLE N. (*with* SOILAND, ALBERT, and COSTOLOW, WILLIAM E.) 91
v. MIKULICZ-RADECKI, F. The Treatment of Uterine Carcinomas in the Clinic of Stoeckel 90
MISCHTSCHENKO, J. P. The Influence of Roentgen Rays on the Function of the Reticulo-endothelial System 89
NAHMMACHER, HANS. The Problem of the Treatment of Uterine Carcinoma and Our Results from 1919 to 1923 and for the Years 1924 and 1925 89
NEEFF, TH. C., and REISNER, A. Sabouraud Doses and r-units 91
PIEPENBORN, J. (*with* HASE, H., and KUESTNER, H.) 84
POLAK, JOHN O. Fifteen Years with Radium in the Treatment of Fibroids, Non-malignant Bleeding, and Dysmenorrhea 88
POLITZER, G. Ueber den Einfluss der Röntgenstrahlen auf die embryonale Linse (The Influence of Roentgen Radiation upon the Embryonal Lens) 88
PONZIO, MARIO. Ionization Measurements in Inhomogeneous Absorbers 87
PORTMANN, U. V. Measurement of Radiation Dosage 92
REISNER, A. (*with* NEEFF, TH. C.) 91
RUNGE, H. Indications and Results of Roentgen Sterilization 85
SCHMIDT, W. (*with* SEULBERGER, P., and KRÖNING, F.) 86
SCHOL, W. (*with* GUTHMANN, H.) 91
SCHURCH, O., and TSCHUDI, E. Experimental Investigations on the Healing of Electrocoagulated Wounds Treated by Radium 65
SEULBERGER, P., SCHMIDT, W., and KRÖNING, F. Roentgen-biologic Investigations on Carcinoma. First Communication: Cytologic Studies on Superficial and Infiltrating Human Carcinoma 86
SOILAND, ALBERT, COSTOLOW, WILLIAM E., and MELAND, ORVILLE N. Radiation Treatment of Uterine Fibromyomata 91
SONNE, CARL. Further Communication on the Dependence of Light Biologic Reactions of the Wave Length of Light 85
STRUMIA, M. M. On the Generalized Effect of Radiations in Myelogenous Leukemia 87
TSCHUDI, E. (*with* SCHURCH, O.) 65
ULLMANN, H. J. The Relation of Fractional to Depth Dose 84
v. WIESER, W. Further Experience with Roentgen Therapy in Psychiatric and Neurological Diseases. I.—Mongolism 65
WIGODER, SYLVIA B. The Effect of X-rays on the Testis 84
WOSKRESSENSKY, N. M. Ueber die Wirkung der Röntgenbestrahlung auf das embryonale Wachstum (The Effect of Roentgen Radiation upon Embryonal Growth) 90

ENLARGEMENT OF THE ABSTRACTS OF CURRENT LITERATURE DEPARTMENT.—RADIOLOGY proposes to devote more space to Abstracts of Current Literature from this time onward, classifying them by subject. The Editorial Board of the Abstract Department is about to be enlarged, enabling RADIOLOGY adequately to cover the field of the world's literature bearing upon the subjects to which this Journal is devoted. —*Editor.*

On Iodin Excretion by the Organism under the Influence of Roentgen Irradiation. J. Arkussky. Strahlentherapie, 1929, XXXI, 806.

The excretion of iodin was studied in cases of malignant tumors. Before irradiation, the patients received iodin *per os* (0.035–0.04 iodin in 100 c.c. milk). Based on a study of 70 cases, the author concludes that patients suffering from malignant tumors retain and store iodin in the body. Under the influence of roentgen rays, an increased secretion of iodin is observed. There is a possibility to develop this method as a prognostic test.

E. A. POHLE, M.D., PH.D.

Contribution to the X-ray Treatment of Pneumonia. Franz Hell. Strahlentherapie, 1929, XXXI, 786.

Many clinics have confirmed the beneficial effect of X-rays in inflammatory diseases. The author treated cases of post-operative and

genuine pneumonia, but comes to the conclusion that the results do not warrant a recommendation of that method in these two diseases.

E. A. POHLE, M.D., PH.D.

Advisability of Roentgenographing Sinus Tracts for Diagnosis. Frederic W. Bancroft. Am. Jour. Surg., June, 1929, VI, 733.

The author reports four cases of lipiodol injection of soft tissue sinuses in which he states that two of the operations would have been failures without the knowledge gained from the roentgenograph, and in the other cases it greatly simplified the operative procedure.

The roentgenographs and artist's drawings illustrating this paper show very graphically the information which can be gained from this type of work and the findings at operation.

HOWARD P. DOUB, M.D.

The Relation of Fractional to Depth Dose. H. J. Ullmann. Am. Jour. Roentgenol. and Rad. Ther., February, 1929, XXI, 174.

In treating deep-seated tumors by fractional doses cross-fired through anterior, posterior, and lateral portals with the purpose of saturating the tumor region and then maintaining the saturation effect for a brief period of time, it has been found that when the lateral ports are used toward the end of the series the total depth dose may actually fall, even while the skin dose is increasing; whereas, if the lateral ports are used first, it will be easier to maintain the saturation effect within the tumor.

J. E. HABBE, M.D.

Contribution to the X-ray Treatment of Ozena. S. Grauer. Strahlentherapie, 1929, XXXI, 801.

Four cases of ozena were treated by roentgen rays, with two methods: either one field including nose and both maxillary sinuses received 75 per cent E.D., or three fields, one over the nose and one over each maxillary sinus, received 50 per cent E.D. each (minimum wave length 0.1 Å., filter, 0.36 Zn. + 2.0 Al.). Doses below 50 per cent E.D. had little or no effect. Three out of the four patients were considerably improved.

E. A. POHLE, M.D., PH.D.

The Effect of X-rays on the Testis. Sylvia B. Wigoder. Brit. Jour. Radiol., May, 1929, II, 213.

The writer investigated by modern histological methods the changes taking place in rat and guinea pig testes after X-radiation, using 85 to 110 K.V. and doses varying from 250 to 8,000 r as measured by Solomon's iontoquantimeter. No definite relationship between the skin dose and the dose producing changes in the testis could be determined. The sterilization dose for the rat was 750 r at 85 K.V., and for the guinea pig a dose six times as large was required to produce similar histological changes. The histological changes observed consisted in a disappearance of normal cell elements (the spermatogonia proving most resistant and the spermatocytes most sensitive), the formation of abnormal cells including giant cells, an overgrowth of Sertoli cells, and a hypertrophy of interstitial tissue.

J. E. HABBE, M.D.

Errors in Measurements with the Standard Instrument (Küstner) Due to Improper Handling. H. Hase, H. Küstner, and J. Piepenborn. Strahlentherapie, 1929, XXXI, 751.

Certain points in the construction of the standard instrument have been criticized. Errors in measuring the dose were explained by these shortcomings. The authors, including the designer of the instrument, present in this article, a series of careful investigations in order to prove that the instrument is perfectly reliable and leads to accurate results if used according to directions. The percentage

of error due to some of the most common mistakes committed in measuring the X-ray dose is discussed.

E. A. POHLE, M.D., PH.D.

Further Communication on the Dependence of Light Biologic Reactions of the Wave Length of Light. Carl Sonne. Strahlentherapie, 1929, XXXI, 778.

The phototropism of oats was studied with monochromatic radiation. It appeared that blue light is 10,000 times as effective as green light and about 20,000 times as effective as yellow light; the violet line 4,050 Ångstroms is also quite effective, but not so much so as blue light. There is a slight decrease in the effect towards the short ultra-violet region. The results are plotted and probable curves drawn. It is assumed that there exists a relation between penetration of radiation and phototropism of plants.

E. A. POHLE, M.D., PH.D.

The Generalized Type of Osteitis Fibrosa Cystica: With Report of Case. William B. Coley and Bradley L. Coley. Am. Jour. Surg., May, 1929, VI, 602.

A report is given describing a case with generalized involvement of the bones. This patient had an associated giant-cell sarcoma, shown by biopsy and later by postmortem examination.

There are apparently two main groups of these cases, the first being without giant-cell sarcoma, and the second with giant-cell sarcoma. The cases associated with giant-cell sarcoma are rather rare and only seventeen cases previous to this one have been found in the literature. A good description is given of the clinical and pathological findings.

The process rarely involves the epiphyses or joints. There is widening of the marrow cavity and irregularity in outline as shown roentgenographically. There is increased translucency of the bones and cystic degeneration, with expansion of the cortex and narrowing of this, together with extensive involvement, making a rather definite roentgenographic appearance.

There are often deformities and angulation from old fractures, and no treatment known at the present time is of much avail.

HOWARD P. DOUB, M.D.

Indications and Results of Roentgen Sterilization. H. Runge. Strahlentherapie, 1929, XXXI, 546.

At the women's clinic (University of Kiel) a total of 265 cases, namely, metropathia hæmorrhagica (126), uterine fibroid (63), excessive menstruation in the pre-climacteric period (54), recurrent endometritis (7), irregular bleeding, with negative examination (12), cachexia (2), were sterilized by roentgen rays. Through three fields, one anterior and two posterior, 40 to 45 per cent E.D. was given to the ovaries. In only 12 cases, or 4.5 per cent, was surgical intervention necessary. Of these cases, there were 5, or 1.9 per cent, which must be designated as failures under X-ray therapy.

E. A. POHLE, M.D., PH.D.

Uterosalpingography. Third Communication:—Safety of the Method, Compilation of Reports of Untoward Results, Contra-indications, Survey of Recent Literature, Discussion of Technic and Therapeutic Applications, and a New Syringe with Manometer Attachment. Julius Jarcho. Am. Jour. Surg., June, 1929, VI, 693.

In this article there is a rather extensive discussion of the whole subject, as the title would indicate, with a very good review of the literature. The article is amply illustrated with roentgenographic reproductions. From the author's experience, he is led to the following conclusions: (1) Recent investigation has corroborated the diagnostic value of uterosalpingography and greatly increased the scope of this procedure. (2) Properly employed with an aseptic technic, and in selected cases, the injection of iodized oil for

roentgenological visualization of the uterus and fallopian tubes is entirely harmless. (3) The contra-indications to uterosalpingography include pregnancy, unless therapeutic abortion is contemplated; gonorrhea; acute tubal inflammation; malignant growths of the uterus, because of the danger of carrying the cancer cells into the peritoneal cavity; menstruation, and profuse uterine bleeding. (4) The injection of iodized oil is of therapeutic value in cases of chronic salpingitis, and they sometimes avoid the necessity of operation on the fallopian tubes for sterility. (5) Even when the diagnosis of a gynecological condition can be made without the aid of uterosalpingography, this procedure has a decided element of exactness as to localization and extent of the lesion. (6) The new syringe with manometer attachment is described, by the use of which the operator can know at any time the amount of oil injected and its pressure.

HOWARD P. DOUB, M.D.

Roentgen-biologic Investigations on Carcinoma. First Communication: Cytologic Studies on Superficial and Infiltrating Human Carcinoma. P. Seulberger, W. Schmidt, and F. Kröning. Strahlentherapie, 1929, XXXI, 467.

Five cases of superficial carcinoma and four cases of infiltrating carcinoma were treated by roentgen rays and biopsy done before and at regular intervals after the treatment. The material was studied histologically. It appeared that the tumors were different as far as number and quality of mitosis were concerned, even before irradiation. Every tumor reacted to the irradiation with a qualitative and quantitative change in the karyokinesis; the time of reaction varied. Changes were also observed in inactive tumor cells; their nuclei dissolved into fine grains or drops. In many tumor cells, particularly in the case of the infiltrating carcinoma, there were changes which might have been due to increased ferment reactions. Following irradiation, there was increased round-cell infiltration and proliferation of connective tissue in the tumor and its surroundings. This is assumed to be a reaction of the organism which manifests itself very characteristically following irradiation. From a clinical standpoint, the authors believe that with the fractional treatment method, the therapeutic results are more favorable. It is necessary, however, to develop a method adapted to the biological reaction.

E. A. POHLE, M.D., PH.D.

Acute Massive Collapse (Atelectasis) of the Lung. David R. Bowen. Am. Jour. Roentgenol. and Rad. Ther., February, 1929, XXI, 101.

While there are many predisposing factors, the actual causation of acute massive collapse is almost without exception the complete occlusion of a bronchus, with subsequent absorption of the retained air.

The most important premonitory sign is a moderate elevation of temperature, the most notable subjective sign is dyspnea, and the most reliable physical and X-ray finding is cardiac displacement toward the affected side. This sign of cardiac displacement is emphasized by the writer, who urges roentgenoscopic study as of greater diagnostic value than films—although if films are taken they should, of course, be made at both deep inspiration and deep expiration in order to demonstrate the displacement. The marked density seen on the X-ray film of the affected lung area is ascribed by the writer as due very largely to vascular engorgement.

The need for constantly "thinking atelectasis" on the part of all working continually with chest conditions is emphasized. Such measures as never allowing post-operative patients prolonged rest in any one posture, limitation of morphine before and after operations, and minimum anesthesia during surgery, will aid in preventing massive collapse. The treatment as advocated by Sante of rolling the patient back and forth on the unaffected side has not proven regularly effective,

hence, bronchoscopic intervention and removal of the obstructing plug of mucus is advocated as a more certain therapeutic procedure.

J. E. Habbe, M.D.

Experience with Continuous Dosimetry in Gynecological Deep Therapy. Paul Feldweg. Strahlentherapie, 1929, XXXI, 566.

The author recommends the use of an integrating dosimeter as designed by Hammer for daily use in the laboratory. A small ionization chamber is placed on the patient and the total dose received is recorded on a strip chart. He believes that this renders X-ray deep therapy much safer.

E. A. Pohle, M.D., Ph.D.

Ionization Measurements in Inhomogeneous Absorbers. Mario Ponzio. Strahlentherapie, 1929, XXXII, 163.

All isodose curves showing the distribution of roentgen-ray intensity in a medium which has approximately the same absorption coefficient as tissue can not be transferred directly to the human body. For instance, the presence of air in the intestinal tract changes the curve materially. Caution must be exercised, therefore, in the use of such in therapy.

E. A. Pohle, M.D., Ph.D.

On the Generalized Effect of Radiations in Myelogenous Leukemia. M. M. Strumia. Am. Jour. Med. Sci., May, 1929, CLXXVII, 676.

The writer gave a patient with myelogenous leukemia two auto-transfusions of irradiated blood and observed after each operation blood changes similar in all respects to those obtained when radiations are applied to the body. A diminution in the size of the spleen was also noted. In a second case of myelogenous leukemia, he applied radium over the lower third of the tibia and the soles of the feet, and observed similar changes. On autopsy, he found no hyperplastic bone marrow in either the tibia or bones of the feet nor any difference in the bones that were irradiated and those that were not.

His conclusions are that radium and roentgen rays affect the hemopoietic centers by an indirect generalized action rather than by direct local effect. In the treatment of myelogenous leukemia, it is the dosage rather than the place of application that is important.

Robert A. Arens, M.D.

Results of the Use of Roentgen Rays in Polycythemia. E. D. Dubowy. Strahlentherapie, 1929, XXXII, 343.

The author recommends X-ray therapy for polycythemia. One E.D. (230 K.V., 0.5 Cu. + 1.0 Al.) over both upper and lower arms and upper and lower legs was given, amounting to 8 E.D in about ten days. The same fields were exposed to 7 E.D. one month later. Four cases responded very well; the symptoms disappeared and the blood count returned to normal. In two other cases, very high doses, *i.e.*, 35 E.D. in four series with six weeks' intervals, or 18 E.D. over a three months' period, were necessary to produce only a moderate decrease in the number of red cells. The symptoms were also improved. It is emphasized that the entire roentgen therapy must be guided by a careful study of the blood count.

E. A. Pohle, M.D., Ph.D.

On the Treatment of Inflammatory Diseases with Roentgen Rays in Small Doses. J. Liebersohn. Strahlentherapie, 1929, XXXII, 356.

Inflammatory diseases respond well to small doses of roentgen rays. In the author's experience, about 75 per cent of his cases improved or were cured. For superficial lesions, he used 120 K.V. through 0.5 Al. to 3.0 Al.; for deep-seated lesions, 180 K.V. through 0.5 Zn. + 1.0 Al. His material comprised 189

cases of skin diseases (eczema, sycosis, lymphadenitis, arthritis, radiculitis, neurodermatitis, pruritus genitalis, acne vulgaris) and 41 cases of various diseases (acute lymphadenitis, abscess, hordeolum, otitis media, sinusitis, periodontitis, tonsillitis, parotitis, lymphadenitis in scarlet fever). He believes, with Fried, that good results are due to an increase in the immunity processes in the organism.

E. A. POHLE, M.D., PH.D.

Fifteen Years with Radium in the Treatment of Fibroids, Non-malignant Bleeding, and Dysmenorrhea. John O. Polak. Am. Jour. Surg., May, 1929, VI, 648.

The author's experience over a long time with many cases has led him to the following deductions: (1) Accuracy of diagnosis is essential, and if there is any doubt in the diagnosis, operation is preferable to irradiation. (2) Highly neurotic or over-sexed individuals, or those with an unbalanced nervous system, should not be treated with radium, as irradiation produces atrophy of the vagina and cervix as well as atrophy of the ovaries and is apt to accentuate all symptoms. (3) The occurrence of other intra-abdominal lesions requiring surgery makes it wiser to operate on many pelvic tumors than to employ radium therapy. (4) Rapid growth of a pelvic tumor suggests malignancy of the uterus or ovaries and complete extirpation is preferable to irradiation. (5) Degenerating pelvic tumors should be removed by operation. (6) Pressure symptoms from large fibroid growths of the uterus are most quickly removed by hysterectomy, as tumor shrinkage from irradiation is variable and uncertain and may never occur. (7) Pelvic inflammatory lesions may become activated by irradiation and may cause peritonitis and death. Hence, in the presence of these lesions, operation is indicated. (8) Large pelvic tumors, pedunculated subserous fibroids, and large submucous growths require hysterectomy, particularly so if there is pressure on the bowel, ureter, bladder, or when metrorrhagia is the common symptom. (9) Radium has proved its usefulness in the treatment of menorrhagia in young girls and in intractable cases of dysmenorrhea without gross extra-uterine lesions. The amount of radiation should never exceed 300 milligram-hours. Treatment may be repeated if necessary. (10) For myomata in young girls or child-bearing women under 35 years of age, myomectomy should be selected, while in multinodular growths with extensive involvement of the myometrium, subtotal hysterectomy with the retention of an ovary and tube should be the procedure of choice. (11) Extremely anemic patients or women in whom the cachexia is out of proportion to the blood picture are bad radium risks. Operation gives better results, but all such operations should be preceded by blood transfusions. (12) In cases with malformation, faulty position, or cervical tumors where uterine drainage is impaired, radium should not be used. (13) Myometrial, exudative processes or adnexitis contra-indicate the use of radium. (14) Finally, careless and indiscriminate use may produce far-reaching damage. Where radium is indicated for benign gynecological conditions, the least amount of radium that will control the situation is the ideal.

HOWARD P. DOUB, M.D.

Ueber den Einfluss der Röntgenstrahlen auf die embryonale Linse (The Influence of Roentgen Radiation upon the Embryonal Lens). G. Politzer. Wien. Med. Wchnschr., 1929, LXXIX, Nr. 17, 551.

The following observations were made on the lens of larvæ of *Urodelæ* after radiation with roentgen rays, filtered with 1 mm. of aluminum and given in doses higher than 8 H. After three months the lens swells and bursts its capsule. The swollen lens fibers enter the eye chamber and the remaining portion is absorbed in the fourth month. Close examination of the eye shows that abnormal karyokinesis appears in the lens epithelium shortly after radiation; these cell divisions lead to the destruction of all the dividing cells. Greater defects in the lens epithelium appear later. Only after large sections of it have

been destroyed is the lens capsule torn and the lens destroyed. It is, therefore, concluded that, at least for the material investigated, the lens epithelium plays the important rôle of protecting the lens from swelling. Other causes of lens swelling (increase of permeability of radiated membranes, in this case the lens epithelium) are discussed. Also, the present status of the radiation effect upon the human lens is briefly stated.

OTTO GLASSER, PH.D.

Current and Potential Characteristics and Fatigue Symptoms in Cadmium Cells Filled with Argon. Konrad Büttner. Strahlentherapie, 1929, XXXII, 403.

The reliability and constancy of the cadmium cell has been questioned recently. The author discusses this problem from mathematical and physical standpoints and comes to the conclusion that, so far as constancy and volt sensitivity are concerned, the cadmium cell is a very exact measuring instrument. The real difference lies in the fact that different cells respond in a different manner to the long wave length range of the spectrum.

E. A. POHLE, M.D., PH.D.

On the Biological Effect of X-rays of Different Quality when the Doses are Measured in R-units. R. Glocker, E. Hayer, and O. Jüngling. Strahlentherapie, 1929, XXXII, 1.

The authors investigated the problem of the biological effect of different qualities of radiation in identical quantities as measured in R-units. Bean seedlings and human skin served as biological objects. Two qualities of radiation were used: 80 K.V., 3 mm. fiber (corresponds to 0.4 Al.), and 180 K.V., 0.7 mm. Cu. It appeared that the skin reaction if judged by the degree of reddening or of pigmentation increased in a different manner when either hard or soft rays were used in increasing doses. For small doses and identical number of R-units, the soft radiation seems to be slightly more effective: in the experiments with bean seedlings, the difference amounted to 15 per cent as maximum. For higher doses, the effect of both qualities in equivalent R-units is practically the same. There was no difference in the erythema and pigmentation curve up to 70 days following irradiation in the same person for both qualities of radiation.

E. A. POHLE, M.D., PH.D.

The Influence of Roentgen Rays on the Function of the Reticulo-endothelial System. J. P. Mischtschenko. Strahlentherapie, 1929, XXXII, 154.

The reticulo-endothelial system is of great importance in the combat of the organism against infection and against malignant disease. Animal experiments demonstrated the fact that the function of the reticulo-endothelial system is considerably inhibited following exposure of the organism to roentgen rays. This observation should be further studied in order to permit its correct evaluation in the treatment of malignant tumors.

E. A. POHLE, M.D., PH.D.

The Problem of the Treatment of Uterine Carcinoma and our Results from 1919–1923, and for the years 1924 and 1925. Hans Nahmmacher. Strahlentherapie, 1929, XXXII, 51.

This paper presents a statistical study of all cases of carcinoma of the cervix (379) and of the uterus (44) observed during 1919–1925. While the details of the very extensive tables must be looked up in the original, it may be stated that the low mortality rate of the cases operated upon is striking. The percentage of good results after three and five years, respectively, of observation varies little. The author feels that three-year statistics are admissible, therefore, under the heading of cures. No radiation is used before operation. In some tables the number of patients, however, is not large enough to permit very definite conclusions.

E. A. POHLE, M.D., PH.D.

Ueber die Wirkung der Röntgenbestrahlung auf das embryonale Wachstum (The Effect of Roentgen Radiation upon Embryonal Growth). N. M. Woskressensky. Ztschr. f. Wissenschaft. Biol. (Abt. D.), 1928, CXIII, Nr. 3, 447.

The embryo of *Axolotl* and larvæ of *Drosophila melanogaster* have been used to study the biological effects with various doses of radiation and the effects which may depend upon the age of the growing organism. From a graphic chart of the results one may predetermine the time of death of the radiated embryo after each given dose at a certain age. From the data obtained it is concluded that (1) sensitivity to radiation of the growing organism decreases with age according to a hyperbolic function; (2) the decrease of sensitivity is synchronous with the decrease of velocity of the growth, and (3) variations in the curve of decrease of sensitivity between *Drosophila* and *Axolotl* are caused by differences in the type of growth and in the processes of cell division in the two objects.

Otto Glasser, Ph.D.

The Treatment of Uterine Carcinomas in the Clinic of Stoeckel. F. v. Mikulicz-Radecki. Strahlentherapie, 1929, XXXIII, 120.

Operation and radiation therapy should not compete with, but supplement, one another. In view of the excellent surgical results in carcinoma of the cervix—48.3 per cent relative cure—the author recommends operation and radiation as combined treatment of all cases of uterine cancer. The patient receives first 6,000 to 7,000 mgh. of radium filtered through 2 mm. of brass in two sittings three weeks apart. Six weeks after the last radium application all primarily operable cases go to surgery; the others as soon as possible. Quite often inoperable cases become operable following radiation treatment. After the operation radium is inserted into the parametrium (300 to 400 mgh.). At last, intensive X-ray deep therapy is given to the pelvis. All recurrences after operation are treated by a combination of X-rays and radium; in these cases needles are inserted into the involved parametrium. While this method was started only about a year previous to the report, the author hopes to obtain better results than before.

E. A. Pohle, M.D., Ph.D.

On the Radiation Therapy of Scleroma. H. Martenstein and G. Jung. Strahlentherapie, 1929, XXXIII, 206.

Following a discussion of the geographical distribution of thirty-six cases of scleroma, the authors present brief histories of nine patients observed from 1902 to 1928, in their clinic. The lesions were treated by roentgen rays or radium. Inasmuch as the roentgen apparatus has undergone considerable change during that period, definite technical data can be given only for the past eleven years. One hundred forty to 180 K.V. were used, filtered through from 1.0 mm. Al. to 4.0 mm. Al., 0.3 mm. to 0.9 mm. Cu. or Zn. For heavy filtration, the erythema dose amounted to 550 r in air. The doses varied considerably in the individual cases. For radium treatment, 27 milligrams radium element in a tube or 24 milligrams mesothorium, filtered through 0.4 mm. of silver, was available. Recurrences were observed five to seven years after the treatment. It is questionable, therefore, if radiation cures this disease.

E. A. Pohle, M.D.

Contribution to the Effect of Radium on Glycosuria in Carcinoma Cases under Irradiation. Fritz Dautwitz. Strahlentherapie, 1929, XXXII, 105.

Very little is known regarding the influence of radio-active substances on glycosuria. After a discussion of the literature, the author relates the history of a woman who received several series of radium treatments for carcinoma of the cervix. At the time of the beginning of the treatment she had up to 6.1 per cent sugar in the urine. The year following the first exposure, there was no sugar present in the urine. In 1928, the patient was

still well: neither the carcinoma nor the glycosuria had recurred.

E. A. POHLE, M.D., PH.D.

Sabouraud Doses and R-units. Th. C. Neeff and A. Reisner. Strahlentherapie, 1929, XXXII, 181.

The authors compared the Sabouraud-Noire Tablet with the Hammer Dosimeter, an ionization instrument with a small chamber independent from the wave length. They confirm the results of previous investigators, finding a definite relation in the sensitivity of the Tablet to the wave length. Considerable deviation was found, however, in regard to the absolute number of R-units for a full Sabouraud-Noire dose. Difference in Tablets and test colors may lead to variations in the dose up to 30 per cent.

E. A. POHLE, M.D., PH.D.

Results of Radiation Therapy in Adenoepithelioma of the Uterus. A. Lacassagne. Strahlentherapie, 1929, XXXIII, 91.

In Regaud's Institute in Paris, a total of 800 cases of uterine carcinoma were seen during the period from 1919 to 1927. Only 30 of these patients had adenocarcinoma of the fundus: they were all treated by radiation. Thirteen of these cases were operable, nine were inoperable, and eight were recurrences following operation. Inasmuch as the results turned out to be far below those obtained in radiation therapy of carcinoma of the cervix, the author believes that carcinoma of the fundus should be treated by surgery until a better radiation technic has been developed.

E. A. POHLE, M.D., PH.D.

Calcium, Pregnancy, and Light. H. Guthmann and W. Schol. Strahlentherapie, 1929, XXXIII, 348.

The authors studied the calcium metabolism in pregnant women in connection with exposure to ultra-violet light. They concluded that while the calcium content drops during pregnancy, there is an increase in the calcium content if the women are subjected to ultra-violet radiation. This increase in the calcium content is undoubtedly very important, because it may prevent a number of diseases occurring during pregnancy, for instance, osteomalacia, nephritis, and eclampsia. It is quite possible that the beneficial effect of ultra-violet light in pre-eclamptic patients, as reported by Hohenbichler, is due to the regulation of the calcium content in the blood. The response to galvanic current was lowered or remained the same as in normal women. According to the investigations of Seitz and Thierry, this speaks for the influence of the calcium and also proves an increase in the calcium content following ultra-violet irradiation. It seems possible to produce an increase in the calcium content in pregnant women permanently by ultra-violet exposure. A systematic treatment of pregnant women by ultra-violet rays is, therefore, recommended.

E. A. POHLE, M.D.

On the Roentgen Therapy of Acute Inflammations in the Inner Ear. R. Goldmann. Strahlentherapie, 1929, XXXIII, 152.

In cases of otitis media the author has seen good results from the administration of small doses of roentgen rays. The field of exposure usually covered the mastoid region, sometimes also the zygomatic, temporal, and occipital regions. *Technic:* 150 K.V., 0.3–0.5 Zn. + 1.0 Al., 10 to 20 per cent E.D. Following initial increase of the symptoms the pain usually disappears, the temperature returns to normal, and pus discharges. If necessary, the treatment may be repeated three to eight days later.

E. A. POHLE, M.D., PH.D.

Radiation Treatment of Uterine Fibromyomata. Albert Soiland, William E. Costolow, and Orville N. Meland. Calif. and Western Med., April, 1929, XXX, 234.

After discussing the methods of treatment, such as low voltage, high voltage, radium, and a combination of radium and X-

ray, and the results of these modalities, the authors reach the conclusion that a combination of radium and deep therapy is the best type of radiation in the majority of cases. They stress the importance of a correct diagnosis before treatment, because, unlike surgery, one cannot change his diagnosis while giving the treatment. They find radiation therapy is practically specific in controlling hemorrhage due to uterine fibromyomata. The majority of fibromyomata may be rendered entirely symptomless even when larger than a four months' pregnancy, and radiation is the treatment of choice in fibromyomata not larger than this.

FRANCIS B. SHELDON, M.D.

The New Tube Stand for Metalix Therapy Tubes. H. Cramer and A. Borm. Strahlentherapie, 1929, XXXIII, 156.

A New Tube Stand in Connection with the Metalix Therapy Tube. Carl Fried. Strahlentherapie, 1929, XXXIII, 160.

In both papers tube stands are described with protective devices to be used in connection with the Metalix tube. The articles are well illustrated and should be looked up in the original.

E. A. POHLE, M.D., PH.D.

Measurement of Radiation Dosage. U. V. Portmann. Am. Jour. Roentgenol. and Rad. Ther., February, 1929, XXI, 170.

The need of a wider utilization of dosimeters calibrated in r-units is emphasized by the author, who describes the various types of dosimeters and mentions the advantages and applications of each. The condensor dosimeter (of Glasser, Portmann, and Seitz) is also described. It is an instrument for comparing the intensities of radium and X-rays in the same unit of dosage, the r-unit. Attention is also called to the desirabilty of expressing the depth dose in r-units.

J. E. HABBE, M.D.

Stereography of the Chest. D. L. Bartelink. Acta Radiologica, 1929, X, Fasc. 2, p. 167.

The author finds fault with the present method for making stereoradiograms of the chest, in that the movement of the heart is not considered. He describes a means of overcoming this fault by the use of a device to make the two exposures coincide with two diastoles, in such a way that the heart has the same conjunction in both. The construction and use of the device are gone into in detail.

M. INGLEHART.